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A Result of Proper Costing?

There are repeated references in the daily Press to the receipt of quotations for all sorts of supplies which vary so little that they are suspect of being the outcome of ring prices. We are not at all convinced that this is the case. For years industry has been subjected to pressure to institute proper costing systems—and indeed, in some cases a nationally unified costing system is in vogue. The price which is paid for labour is standardized as the result of negotiations with the trade unions. The cost of raw materials and services is in many cases fixed by such bodies as the Coal, Electricity and Gas Boards, and by the Iron and Steel Board, and so varies but little. Another factor which no doubt tends to level out prices is depreciation and here the more highly mechanized concerns will plough back more money than those concerns which have not spent such large amounts of capital. Thus the gap between the selling prices does tend to narrow. In the old days there was too much guesswork and moreover, when trade was languishing, uneconomic prices would be accepted to keep the staff together.

The small differences in these contract prices are probably a better testimonial to intelligent costing than evidence of a monopoly. A factor in buying which should annoy a public body, or indeed an individual, is the knowledge that after an order has been placed, it is found that there exists a cheaper source of supply. On several occasions, we have bought goods on the Continent only to find that they were available in the shops of this country at the same price or even cheaper. This is really obvious, as bulk wholesale importation does reduce the Continental and domestic prices to virtually the same level. For the selling of most goods to the home market, the main variables are not the manufacturing costs, but overheads and transport. The impact of the latter is in some cases negligible, as the larger concerns have works strategically placed throughout the country.

When a section of the foundry industry was being investigated to ascertain whether or not a monopoly existed, evidence from the customers indicated that they appreciated standardized prices as it saved them money by eliminating the need to make repeated calculations of their selling prices. Any concern which operates a properly controlled costing system and fixes reasonable selling prices on that basis has a clear conscience and should have little fear from the innuendoes now being made. As the units of an industry instal efficient costing methods associated with intelligent manufacturing operations, so too will the overall selling prices tend to be of the same order for the same class of goods, and the wide variations of the past will become increasingly obsolete.

Correspondence

SHELL MOULDING WITH CO_2

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—As a regular reader of the FOUNDRY TRADE JOURNAL, I have seen much discussion of the Carbon-dioxide Process recently printed. May I make a suggestion for a further application of this process? Why not "marry" shell moulding with the CO_2 Process?

A plaster pattern of the desired casting would be made and the sides painted with an impervious paint. Around the top of the pattern would be packed the sand/silicite mix to the required thickness, perhaps, ½-in. Carbon-dioxide would then be blown through the bottom of the pattern and thus a shell of very good dimensional accuracy produced.—Yours, etc.

M. LUCAS.

Southampton
May 26, 1955.

[It is believed that several foundries are already proceeding along these lines.—EDITOR.]

International Foundry Congress Transport

If the railway strike continues, it may be necessary to organize "mutual-help" transport for the British participants in the International Foundry Congress to reach London. Will those requiring or able to offer lifts to the Congress please make known immediately their needs or offers to the secretary of the Institute (St. John Street Chambers, Deansgate, Manchester, 3). Details required in either circumstance are: Date and time of travelling, starting point and number of places. It will be appreciated that if such information is already in the hands of the secretary, at short notice he can put those requiring help into touch with those offering it, if the state of emergency continues.

Aluminium Exhibition

Tomorrow morning (Friday) HRH the Duke of Edinburgh is to visit the centenary exhibition of the Aluminium Development Association at London's Royal Festival Hall. He will later be the guest of honour at a luncheon given by the council of the Association on HQS Wellington. Delegates to the joint meeting of American and European metallurgical societies are invited to visit the exhibition in the afternoon.

The exhibition has been arranged by the ADA to give technical advice and information about aluminium, and it is intended to show some of the many ways in which aluminium is used and the part which British industry has played in its development. As Dr. Horace W. Clarke, the president of the association, said at a Press preview on Tuesday, the reason for holding the exhibition in 1955 is that it is just 100 years ago since the first particles of aluminium were made in this country. During the period of the exhibition, a series of discussions, each on a specific field, will take place in the Recital Room of the hall. The exhibition will remain open until next Friday.

THE ANNUAL GENERAL MEETING of the London and Home Counties area of the Association of Bronze and Brass Founders will be held on June 7, 11.30 a.m., at the Clarendon Restaurant, Hammersmith. It will be followed by a meeting of the Advisory Service at 2.15 p.m. when a talk will be given by Mr. A. Talbot on the "CO_2 Process in the Jobbing Foundry."

Strike Emergency

Every effort will be made to continue with the normal issues of the "Foundry Trade Journal" in the present emergency arising from the rail strike. It is pointed out, however, that restrictions imposed by the Post Office authorities on permitted size or bulk distribution of printed matter may cause some curtailment at short notice of editorial and advertisement content of the "Journal" if the strike continues.

BNFMRA Open Day

Last week, an "Open Day" was held at the Euston Street, London, laboratories of the British Non-Ferrous Metals Research Association. Earlier in the day, the premises and work in progress were inspected by HRH the Duke of Edinburgh; he was received by the Hon. R. M. Preston, D.S.O., chairman of Council from 1950-1954. The Duke, in the accompanying illustration, is shown examining the Association's shell-moulding exhibit. (Particulars of the Association's work in progress of direct interest to founders were printed in the JOURNAL, May 19, 1954, page 540.) It is understood that the work of the Association on shell moulding includes an investigation into methods of securing flatness in plate-like castings—a research which is beginning to show some positive and extremely valuable results. Details will shortly be made available to members of the Association.

Place of Shell Moulding in the Foundry*

By B. H. C. Waters, M.A., Ph.D.

This Paper attempts to assess the place of shell moulding in the foundry. The techniques of the process are considered first, since from them, and from the ease or difficulty with which they can be applied spring the advantages and limitations of shell moulding. In the light of this some of the possible competitive processes of shell moulding are assessed.

Introduction

As is well known, in shell moulding a resin/sand mixture is dumped on to a heated metal plate so that a thin skin, some ¼-in. thick, is formed. Subsequently, excess mixture is removed and the patternplate and shell are heated, causing the resin to cure, setting it into a biscuit-like contoured shell. This shell is removed from the patternplate and used to form one half of a mould used for metal casting. The operation of a shell-moulding machine is shown in Fig. 1.

Machines Used

The types of shell-moulding machine at present used may be divided into three classes, and American machines are used as illustrations. One type is the fully-automatic machine, an example being shown in Fig. 2. This machine incorporates a large number of controls and consequently it is somewhat complex, requires skilled maintenance, and is expensive. A much simpler and cheaper type of machine is shown in Fig. 3. This machine requires manual operation, the patternplates being swung over the dump-boxes by hand, and the oven is moved by hand. However, it has a simplicity of operation not possessed by the first type. The third type of machine, shown in Fig. 4, is tailor-made to suit a particular production layout and capacity. It has the advantage that it can be made to suit a particular plant and operational method. The design of machine of this type varies greatly with the conditions where it is used. That shown in Fig. 4 is used for a mass-production shop: for smaller production, a much simpler machine is needed and is used.

Shell Thickness

The thickness of a shell mould is related to the patternplate temperature and the "dwell" time in investment. Data for the relationship between the shell thickness formed and the dwell time have been given by Dixon and Bushnell[1] and are shown in Fig. 5. The full lines in this illustration relate to the calculated thickness, assuming a thermal diffusivity of the sand of 0.005 c.g.s. units and a cohesion temperature for the resin on the sand grains of 55 deg. C. This apparent cohesion temperature is considered to be too low, since some sand grains adhere physically to the shell. Although not as low as 55 deg. C., the grain-cohesion temperature is below 100 deg. C. and the resin must not be allowed to get too hot during mixing of the sand, otherwise balling-up may occur. Sand mixing may be avoided by using a pre-coated sand. It is stated that this method has the advantage of giving a uniform resin coating to the sand grains so that less resin is required for a given shell strength.

Curing Conditions

After the resin/sand mix is formed in contact with the shell, the pattern with the adhering mixture is removed from the dump-box and reheated to cure it. This curing temperature must be adjusted to give a maximum shell strength. The best method of controlling this is by eye, using the colour of the shell as a guide.

A transverse test may also be employed, the load required to fracture a beam of the cured shell being noted.[2] Modern resins permit considerable flexibility in that when any over-curing takes place, the falling-off in ultimate tensile strength is not very

FIG. 1.—*Operation of a shell-moulding machine.*

* Paper read before the Sheffield branch of the Institute of British Foundrymen, Mr. E. Ayres presiding.

marked (Fig. 6). Although the load required to fracture a cold shell is not the same as that required for shell fracture at an elevated temperature, a transverse test can be used to guard against under-curing.

Shell Resin Content

The resin content of a shell mould is an important factor in the process, if only because the resin cost forms a large part of the total shell cost. The resin content needed for a casting depends largely on the melting point of the metal used. This is because the outer cooler layers of the shell must retain sufficient strength while metal is flowing into the mould to maintain mould shape. Shells containing high-melting-point metals heat up more quickly, and hence lose their strength more quickly than shells containing low-melting-point metals. Increased strength can be achieved by increasing the resin content of the shell, the relative increase in strength with increasing resin content being shown in Fig. 7.

The shell strength actually required depends on whether the shell is cast vertically or horizontally. Normally, a vertically-cast shell has to withstand greater metallostatic pressure than one poured horizontally. Therefore it must be made stronger, either by increasing the resin content or increasing the shell thickness. This latter variable has been investigated by means of a hot-penetration test. This is carried out with the apparatus shown in Fig. 8. A shell-thimble 2-in. high is inverted in molten aluminium, and the time required for penetration by a loaded, refractory-sheathed thrust-rod is measured. Results are shown in Fig. 9 from which it is evident that these times increase markedly for shells over ½-in. thick. The penetration times correspond to a shell-face temperature of about 800 deg. C. They are less than would be expected, and give an effective shell thermal diffusivity of 0.084 c.g.s. units. A calculated curve for a shell or diffusivity 0.005 c.g.s. units is also shown.

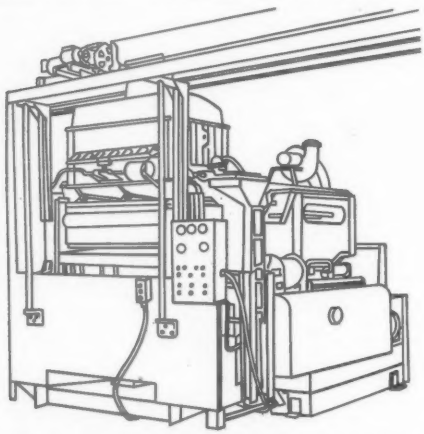


FIG. 2.—*Automatic type of shell-moulding machine.*

The experimental curve in Fig. 9 shows that very thick shells are strong. However, they have disadvantages in that gas evolution is increased and there is a decrease in shell permeability. As a result, efforts have been made to get high shell-strength with good permeability by backing a shell made of fine sand with coarse shell-sand reinforcement. Normally in shell casting, however, a shell is strengthened by backing-up.

Back-up Materials

As a rule, if a shell is not strong enough to support the molten metal, it is strengthened by backing-up with such materials as sand, gravel, or steel shot. As a secondary function this back-up material may affect the grain size of the casting poured, by influencing the cooling rate and hence the solidification time of the casting. Morey, Bishop, and Pellini[3] have shown that for gunmetal cast in a ¼-in. thick shell, the times of complete solidification for shells cast with shot and gravel back-up are about 80 and 90 per cent. respectively of those for gunmetal cast in green-sand moulds. For steel, these complete-solidification times are about 70 and 90 per cent. respectively, while for steel cast in a thick shell-mould (1-in. thick) the solidification time is about 140 per cent. that of steel cast in a green-sand mould. These figures show that no great change in solidification time can be expected by variation of back-up materials, and thus backing-up can only affect grain-size to a minor extent: the mode of solidification of a metal is not altered, since to do this the solidification time must be changed by a factor of from 5 to 10.

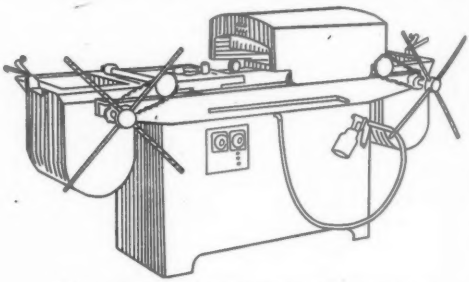


FIG. 3.—*Hand-operated shell-moulding machine.*

Control of Casting Structure

Casting temperature plays a considerable part in determining the final grain-size. Magnets cast in Alcomax alloy and fractured to reveal the grain-size as-cast are shown in Fig. 10. This shows that the grain-size of the casting is decreased by lowering the casting temperature.

Possibly, in the future, external cooling means such as water sprays or air blast may be used to give some control of the mode of solidification. Use of such means would permit advantage to be taken of the fact that a shell casting can be got at much more easily than a sand casting. No artificial cooling

could be applied until the shell was burnt away: hence the figures previously calculated for shell diffusivity are important. The rate of solidification of steel can be calculated and is shown in Fig. 11, where figures taken from Briggs and Gezelius[4] are also shown. It may be noted that while the curves would be expected to agree within an order of magnitude, the precision of their agreement is fortuitous. Again, both curves may be inaccurate at longer times, but they are used as a basis for comment on a short-time process. Calculated times required for the shell surface to rise above 800 deg. C.— when the shell is very weak because by then the resin is burnt away—are shown in Fig. 12. These figures show that it is theoretically possible for a drastic form of cooling to be applied effectively to a casting in a shell 0.25-in. thick about 10 sec. after casting, and that this would be expected to have an effect on all but the outer 0.2 in. of metal. Such external cooling would be more effective with thinner shells. An effectiveness commencing at about $\frac{3}{16}$ in. deep would be desirable. This minimum thickness can be secured, but to obtain it close control of the patternplate temperature must be exercised, and also it is important to ensure that the shell is not thinner at the corners than elsewhere. To do this, it is desirable to radius the top corner of shell patterns whenever possible.

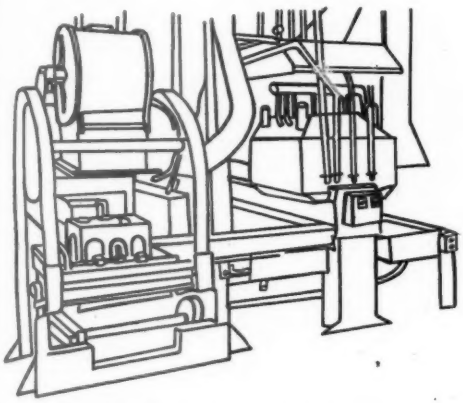


FIG. 4.—*Specially-designed shell-moulding machine.*

Quality of Shell-moulded Castings

An important advantage of shell-moulded castings over ordinary sand castings is that it is often possible to hold closer dimensional tolerances and to obtain a better surface in shell castings than can be achieved in sand castings. A comparison between metal cast under comparable conditions into a sand and shell mould is shown in Fig. 13. The precise shell surface is very dependent on the metal condition: in Fig. 13 the shell surface is determined more by the steel surface-tension than the shell sand-grain size.

With aluminium and most types of gunmetal, the surface obtained with shell-moulded castings is usually very good. The main imperfections result from possible entrainment of dross in the casting stream. Slag is important with steel casting. It is essential that slag should be removed from the metal stream before it enters the mould, since slag which can be tolerated in ordinary castings, where the outside surface is considerably machined, cannot be accepted in shell-moulded castings. Ideally, shell-moulded castings should be bottom-poured, but this is often impossible in practice due to the difficulty of controlling the metal stream. If lip-pouring is employed, a teapot ladle or slag weir should be used, and the metal tapped into the ladle with the slag held back at the start of tapping and the ladle should be so adjusted that the first metal enters it with a swirling action and a minimum of slag rises in the teapot spout. As an additional guard against occluded slag, the castings should be choked and care taken in pouring to ensure that the downgate is filled at the start of the teem and is subsequently kept full.

Shell Permeability

A shell mould is much thinner than a sand mould, so that it has a greater permeability. Actual permeability figures for shells are of the same order of magnitude as those for sand, typical figures being 85 for a standard shell and 110 for a pre-coated shell compared with 99 for the "magnet sand" used in the Author's works and 118 for facing sand. As shell moulds are much thinner than the sand moulds they replace, a given amount of gas will pass through a shell mould about six times as fast as through a sand mould. Because of the greater effective permeability of shell moulds, metal can normally be cast into a shell mould some 20 to 30 deg. C. cooler than into a corresponding green-sand mould.

Casting Finish and Accuracy

A source of trouble encountered with steel castings, and especially castings in stainless steel, is carbon pick-up. This can occur to the extent of about 0.1 per cent. in the outer 0.01 in. of a stainless steel casting. Low carbon stainless steel when cast in a sand mould employing an organic binder also shows carbon pick-up. In this case, however, it is less deleterious than with a shell-moulded casting because the pick-up is only about half that with shell castings, while a sand casting is usually much more extensively machined.

No evidence of extensive carbon pick-up in plain, carbon steels has been published, but there is much evidence of the formation of circular-shaped depressions. Examples of such depressions are shown in Fig. 14. This illustration shows a comparison of a shell-moulded casting weighing about 58 lb. with a similar green-sand casting. The top row shows the bottom surfaces of the castings before shot blasting and demonstrates the cleaner strip associated with the shell-moulding process. The middle row shows the bottom surfaces after shotblasting: that of the shell is much better than the sand

Place of Shell Moulding in the Foundry

surface. The bottom row shows the top and bottom surfaces of the shell castings after shot blasting. The top of the shell casting is inferior to the sand casting due to the depressions, which tend to congregate around the feeder head. The cause of these depressions is uncertain, but since they occur mainly near heavy sections it has been suggested, and appears likely, that insufficient feeding is responsible. If this be so the outer skin first formed is presumably subsequently remelted in local areas due to convection currents in the liquid metal, and it is at these locally re-melted zones that depressions occur.

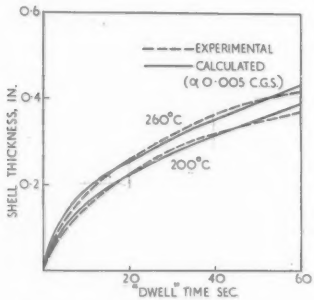


FIG. 5.—*Relation between shell thickness and "dwell" time.*

It is also possible that entrapped gas might cause these pits. The gas evolved from a resin shell is rather large, as shown in Fig. 15, where comparisons are given between resin sand and the standard moulding materials shown in Table I. The determinations were made by the method recommended by the Institute of British Foundrymen.[5] On the other hand, it seems probable that the shell permeability would be ample to allow any gases generated to escape. Also, gas defects in shell-moulded castings usually have an appearance different from that of these depressions.

TABLE I.—*Compositions of Moulding Materials.*

—	Moulding sand per cent.	Moulding sand with organic binder per cent.	Core sand per cent.	Magnet facing sand per cent.	Shell-moulding sand per cent.
Arnolds 2A sand ..	37	36.5	41	—	—
Unwashed Chelford sand ..	37	36.5	41	27	—
Minimum sand ..	—	—	—	65	—
Redhill "H" sand ..	—	—	—	—	94
Silica clay (Parsley Hay)	20	19	—	—	—
China clay	—	—	10	—	—
Western bentonite ..	1	1	—	2	—
Core cream (*a*) ..	—	2	4.5	—	—
Glyso semi-solid core-compound (*b*) ..	—	—	—	4	—
Moisture (*c*)	5	5	3.5	2	—
P.F. resin	—	—	—	—	6

(*a*) Contains approximately 1/3 linseed oil, 1/3 dextrin and 1/3 water.
(*b*) Contains oil, molasses, starch, water.
(*c*) Note results in Fig. 15, given for dried samples.

Defects in shell-moulded castings may arise from a poor surface due to sand and silicone build-up on the patternplates, from run-outs due to the sand being burnt through or from flash occurring when an incorrectly closed or poured shell opens up at the parting line. Defective castings are shown in

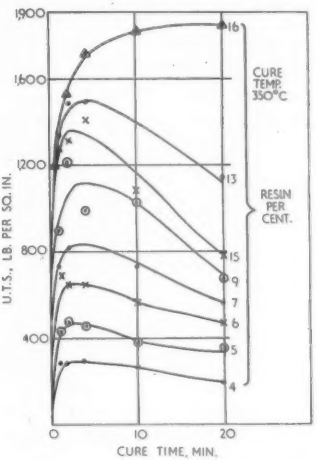


FIG. 6.—*Relation between ultimate tensile strength of shell and resin percentage, for various curing times.*

Fig. 16 where flash formation and the effects of silicone build-up on the patternplates are shown.

Flash formation may be due to the fact that the casting poured is too heavy, or the metallostatic pressure too great, as may occur in some vertically-poured castings. Metals of higher melting-point are normally more prone to flash formation, and the greater the metal fluidity the greater is the danger of flash. A rough rule for determining the method of casting to be adopted in any particular conditions, with steel, is shown in Table II. In this, however, it should be emphasized that it may be preferable to cast horizontally castings which it is possible to cast vertically.

TABLE II.—*Details of Possible Methods for Pouring Steel Castings in Shell Moulds.*

Max. individual casting weight, lb.	Max. weight of casting spray, lb.	Cast vertical or horizontal.	Back-up or not.	Max. section-thickness, in.
1	12	Vertical	No	0.75
10	20	Horizontal	No	1.5
over 10	over 20	Horizontal	Yes	over 1.5

Very close tolerances can be held with shell-moulded castings, particularly with the lower-melting point materials. Tolerances can be held across selected critical dimensions as close as 0.002 in. per in. of casting. It has been reported that in some grey-iron castings tolerances of 0.004 in. in 4 in. have been held, so as to cut out a machining operation. This was acheived with moulds backed up with sand. Exceedingly close tolerances are very

often unnecessary, and attaining them may be in some cases difficult, and in all cases expensive, but nevertheless such values can be achieved.

The development of patterns is normally a matter of trial and error, since in addition to other casting variables shell moulds shrink during curing by about 0.004 in. per in., if free contraction is permitted, but the actual contraction experienced depends on the amount of restraint applied to the shell moulding during curing. If the shell be free to shrink, a greater allowance must be made for effective metal shrinkage.

Running and Risering Systems

The runner systems which can be used with shell-moulded castings can be smaller than those necessary for sand castings. Thus less runner metal is needed, and consequently economies in metal

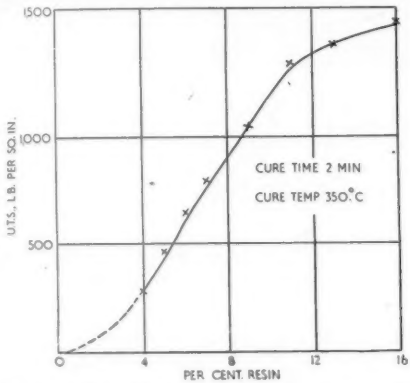


FIG. 7.—*Relation between ultimate tensile strength of shell and resin content for a cure of 2 min.*

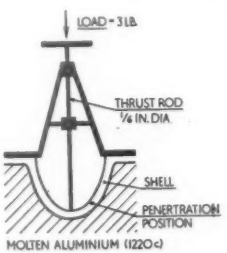


FIG. 8.—*Thimble-test apparatus for hot-penetration of shell.*

melted are possible. This is because, first, the friction between metal and a shell mould is almost certainly less than that between metal and an ordinary sand mould, although no reliable figures of this effect exist. Secondly, a shell mould is more insulating than a sand mould so that there is a smaller tendency for metal poured into it to solidify against it.

It has been suggested that shell-moulded castings need only smaller risers than ordinary sand-moulded castings. However, this has not been confirmed in practice, except in so far as shell castings can often, with reduced machining allowances, be made smaller than the sand castings they replace, so that they require less feed metal. For some very specialized castings, a certain amount of central openness of grain may also be tolerated, because shell castings typically form a sound surface, and, if machining be light, there is little danger of machining penetrating to the central unsoundness. Thus, such alloy-steel shell castings can sometimes be given less feed metal than sand castings. Castings like these are, however, exceptional. Usually, advantage is taken of a shell casting by reducing the machining allowance while maintaining full riser dimensions. Shell casting sometimes enables sounder castings to be obtained than can be obtained with sand castings. Occasionally some sand castings may, after heavy machining, be found porous because the sound outer layers have been machined away. This can be avoided by appropriate employment of a shell technique, using reduced machining allowances.

Summing up, it may be said that in running and risering the same principles apply to both shell and

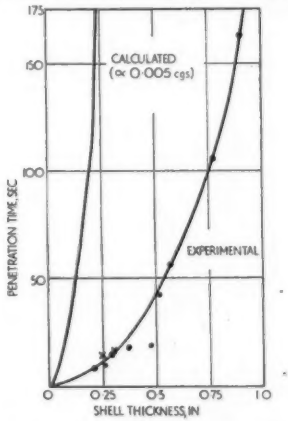


FIG. 9.—*Relation between penetration-time and shell-thickness for a shell containing 6 per cent. of resin (bath temp. 1,220 deg. C.; load 3 lb.; experimental curve gives effective* $\alpha = 0.084$ *c.g.s.).*

sand casting, although the application of these principles may lead to a system in shell-moulding which is very different from that of ordinary sand-moulding.

Shell-mould Closing

Perhaps the most difficult technique of all, and one which still remains to be really solved, is that of shell-mould closing. Methods of closing shell moulds may be divided into two types—one clamping and the other sticking.

The most obvious clamping method is that employing clips, bolts or C clamps: such methods as these are still widely used, although with them shell

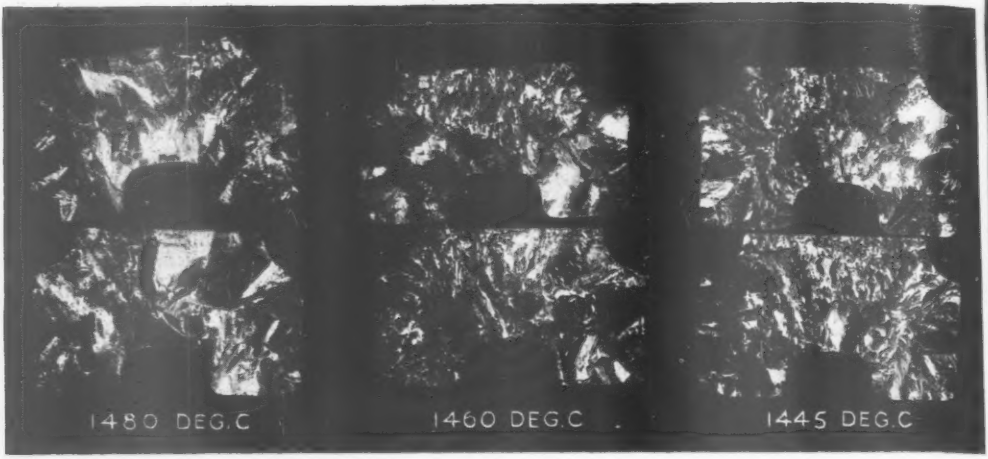


FIG. 10.—*Shell-moulded magnets (Alcomax) cast at different temperatures and fractured to show grain-size. Casting temperatures as shown (reading taken by optical pyrometer focused on the casting stream).*

closing becomes a time-consuming process and recovery of the clamps is troublesome. Backing-up is another technique which effectively clamps shells together, although this also has the disadvantages of taking time, needing capital equipment, and possibly requiring recovery systems for the back-up materials. Backing-up is, however, advantageous when casting to very close tolerances. A further shell-clamping technique is that using air cylinders which compress the shells together by means of fingers or plates. The main disadvantages of compressed-air clamping appear to be the requirement of capital equipment, the vulnerability of this equipment to metal splash, and the relative inflexibility of this closing method.

The sticking techniques used can be divided into two classes. In one type, two cold shells are used, the sticking resin being placed on one shell and the accelerator on the other before closing. Alternatively, using cold shells, the resin may be set by di-electric-loss heating. In the other type of closing, one hot shell and one cold shell are used. The sticking resin is placed on the cold shell, and the hot shell is then placed on it, the heat from the latter causing the resin to set. With this hot-and-cold-shell technique and with large shells difficulties may arise from the differential thermal expansion of the two shells.

With all sticking techniques, a key to the process is the method of holding the shells together whilst the resin sets. This may be done by means of rubber diaphragms, or by loaded mechanical fingers. In all methods, the aim is to apply pressure to the shell as uniformly as possible.

Shell Moulding in Relation to Rival Processes

The obvious competitor to shell moulding is sand moulding. In Fig. 17 a number of magnets that have been made by the shell process are shown. In magnets A, B, and C, a shell mould has been used in preference to sand because it has permitted greater yields to be achieved. Magnet D, incorporates a shell core which was difficult to make in sand. In magnet E, a shell has been used because it has justified itself by reducing machining costs. Other magnets are made in shell moulds where close casting tolerances are required.

A comparison of shell- and sand-moulding costs is shown in Table III. Here it will be seen that the shell process can, with expensive alloys, sometimes be made to justify itself in terms of increased yield alone, the increased yield arising from a reduction in runner size. Normally, however, as in the alloy-steel casting, justification for its use must be sought in terms of reducing machining allowances.

TABLE III.—*Cost (in pence) of Producing Typical Magnet and Alloy-steel Castings.*

Item.	Magnet.		Alloy steel.	
	Sand.	Shell.	Sand.	Shell.
Moulding	0.251	0.075	1.52	0.34
Closing	—	0.076	—	0.37
Fettling	0.604	0.148	1.43	1.42
Shot-blast	0.078	0.078	0.97	0.95
Steel cost	14.744	14.450	36.54	34.38
Refractories ..	0.835	1.172	1.20	7.35
Closing materials ..	—	0.125	—	6.50
	16.512	16.124	41.66	51.13

Having thus briefly compared sand and shell moulding a larger list of competitors is considered:—

(*a*) Conventional sand moulding.
(*b*) Precision-investment casting.
(*c*) The "D" process.
(*d*) High-pressure moulding.

The last two processes are interesting because they are fairly new. Comparing the various processes is difficult since so much depends on individual situa-

tions, but a semi-quantitative comparison is given in Table IV. The grading is in terms of A, B, C, D, or E, the A indicating most favourable conditions.

TABLE IV.—*Comparison of Shell-moulding and Similar Processes.*

—	Sand moulding.	Precision casting.	Shell moulding.	"D" process.	High-pressure moulding.
Development most advanced	A.	B.	C.	D.	E.
Finish obtained	E.	A.	C.	D.	B.
Accuracy ..	E.	A.	C.	D.	B.
Running cost (large fdry.)	A.	E.	D.	B.	C.
Production rate	B.	E.	A.	C.	D.
Capital cost ..	B.	E.	A.	D.	C.
Carbon pick-up	B.	A.	E.	D.	C.
Plain C. pitting	B.	A.	E.	D.	C.

In the first line an estimate is made of the extent of advance of the process considered. The other columns must be interpreted in the light of this first column, since the accuracy, for instance, of cost information on high-pressure moulding is not very great. It is only being experimented with to a limited extent. Broadly speaking, the development

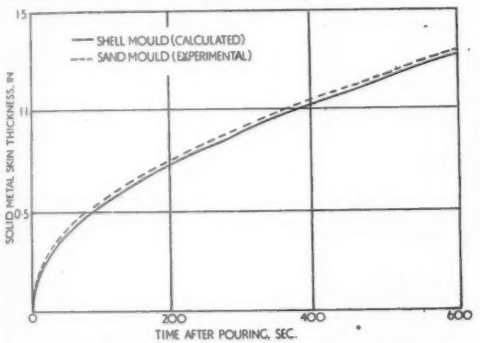


FIG. 11.—*Calculated and experimental curves for steel solidification, showing relation between solid-metal-skin and thickness and time.*

of the first three processes has progressed to an extent where they may be considered as part of standard production; the last two processes are not. Having been accepted as a standard production method, however, the fact that a process is less highly developed is probably an advantage, since it indicates that greater potentialities for development exist. This is true of shell moulding, where there are indications that the cost of the resins used can be reduced by using smaller resin percentages. Within the last two years it has become customary to talk in terms of 6 or 7 per cent. resin for steel instead of 8 or 9, while aluminium is now cast in shells the resin contents of which are down to 3 or 4 per cent.

In lines 2 *and* 3, surface-finish and accuracy obtainable with the various processes are considered, properties which go together. Precision-investment casting is certainly the best while sand casting is the worst for most materials, though, as has been pointed out, with some materials such as low-carbon steels shell moulding gives a surface finish which is inferior to that obtainable by sand moulding. The accuracy of high-pressure moulding is assessed in this table as being very great, being "apparently limited only by the accuracy of the pattern equipment."[6] This, however, is based only on very early claims and is certainly subject to confirmation.

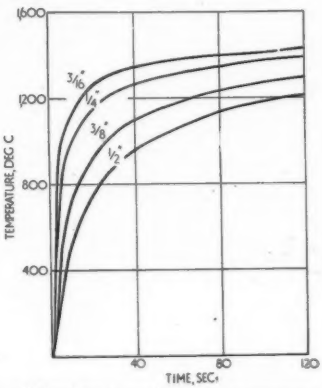
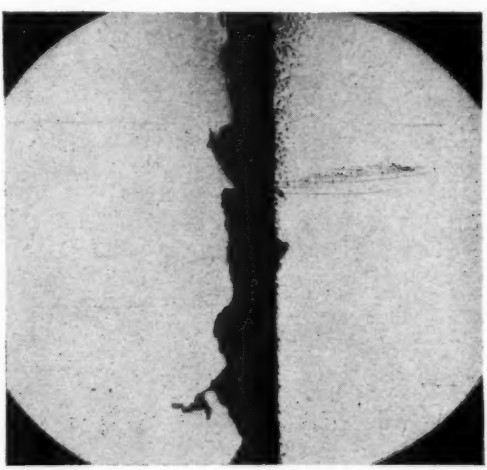


FIG. 12.—*Calculated surface temperatures of shells containing steel at* 1,550 *deg. C., for* α *shell* = 0.084 *c.g.s.*

In line 4, running costs are considered. Of the three commercial processes, the order is: Sand, shell and precision casting. The positions assigned to the "D" process and high-pressure moulding are based on estimates from experimental work. For the "D" process it is claimed that only small amounts of cheap resin or oil-binder are needed. For high-pressure moulding similar claims are

FIG. 13.—*Casting surface for* 18/4/1 *tool-steel metal; left, sand-moulded and right, shell-moulded;* × 50 *(approx.).*



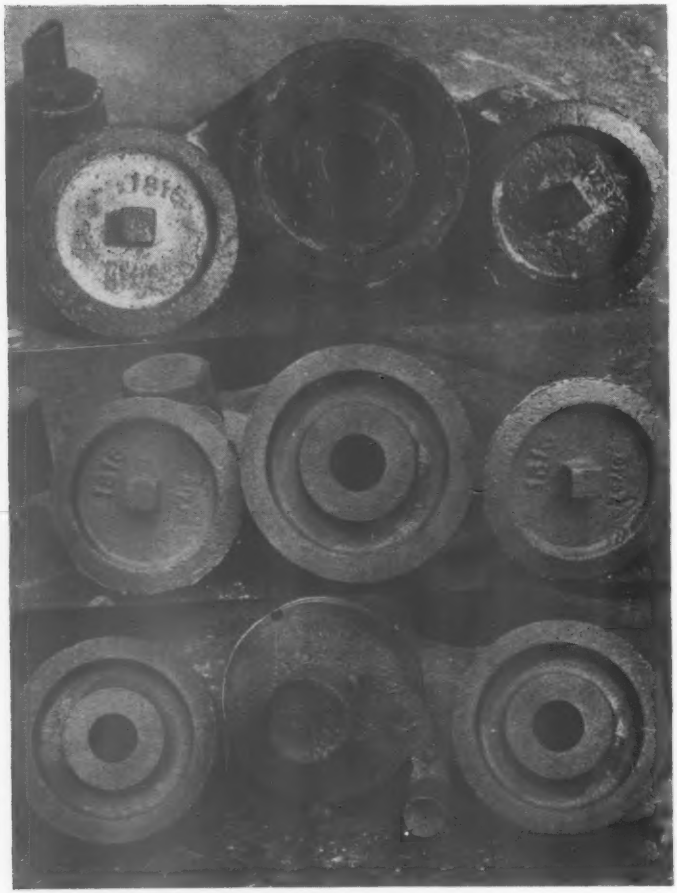


FIG. 14.—*Comparison of similar sand- and shell-moulded castings. The casting with a square boss is sand cast and the others are made in shells.*

made, with the additional one that no sand recovery is needed.

The production rate is considered in *line* 5; this is related to the running costs and the order is approximately similar to that for the running costs. With some shell-moulding installations, there may be no very great difference between the production rate for sand and shell moulds, when closing time is considered.

Line 6 relates to the capital cost of installations. It is an advantage of shell moulding that these can be quite low if simple equipment be employed. However, pattern costs will be in the region of three times the corresponding pattern costs for sand moulding, though about the same as the pattern costs of precision-investment casting. In this assessment of capital equipment costs, those for high-pressure moulding are again a matter of conjecture. Possibly, however, an accuracy approaching that of high-pressure moulding could be obtained by diaphragm moulding, and the costs for this would probably be similar to sand moulding.

TABLE V.—*Comparison of Shell-Moulding and Overlapping Processes.*

	Precision casting *v.* shell-moulding.	Baked-sand casting *v.* shell-moulding.	Precision forging *v.* shell-moulding.	Welded assemblies *v.* shell-moulding.	Machined parts *v.* shell-moulding.
Overall cost	Shell cheaper.	Baked sand cheaper	Forgings cheaper.	Shell cheaper.	Shell cheaper.
Degree of complexity	Investment better.	Shell better.	Shell better.	Evenly matched.	Shell better.
Tooling cost	Shell cheaper.	Baked sand cheaper.	Shell cheaper.	Welding cheaper.	Hard to compare.
For large parts	Shell better.	Baked sand better.	Forgings better.	Welding better.	Machining better.
For small parts	Investment better.	Shell better.	Shell better.	Evenly matched.	Machining better.
Life of tooling and pattern	Evenly matched.	Shell better.	Shell better.	Welding better.	Machining better.
Accuracy and finish	Investment better.	Shell better.	Shell better.	Evenly matched.	Machining better.
Intricacy	Investment better.	Shell better.	Shell better.	Shell better.	Machining better.
Time for first sample	Shell better	Baked sand better.	Evenly matched.	Welding better.	Machining better.

Lines 7 and 8 relate to carbon pick-up and surface-pitting in steel. Assessments of high-pressure moulding and the " D " process are based here on what one might expect from the amounts of resin used. These two lines are primarily of interest in the comparison they afford between sand and shell moulding. In each case sand moulding is superior, although if an organic binder be used, even sand moulding gives some carbon pick-up.

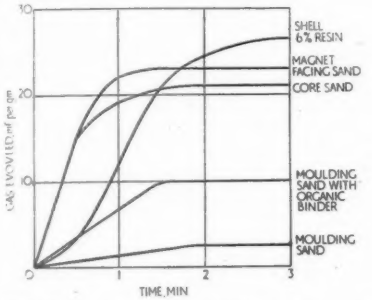


FIG. 15.—*Rate of gas evolution from various moulding mixes at a testing temperature of 1,000 deg. C.*

A comparison of shell moulding and other overlapping processes is given in Table V which is taken from a paper by Dunn and Day.[7] As has been pointed out, a general comparison such as that shown is difficult, but the attempt does help clarify ideas. Essentially, the first two columns in this Table have already been considered.

Comparing forging and shell moulding, it is evident that shell moulding has many advantages, although for larger parts where large quantities are required forgings are cheaper and may be better. At the moment, forgings probably have a particular advantage over shell in plain carbon steels. Welded assemblies also represent competitors to shell moulding. The primary advantage of a weldment over a shell-moulded job is in applications where only small numbers off are needed, and particularly where the parts required are relatively large. At the present day, there is little restriction on the type of material that can be welded. The last column of the table compares shell-moulded and machined parts. For large parts, machining is better: the advantage of the shell-made item is mainly its relative cheapness, a factor which may in some applications be very important.

FIG. 16.—*Shell-moulded castings, showing flash formation (left group) and effect of silicone build-up on the pattern-plate (right group).*

Conclusions

The following conclusions emerge from the previous consideration :

Shell moulding is normally limited to the production of components for which there is a large demand, since at the moment metal patternplates are needed. It has been suggested[8] that it is economic to produce items required in numbers of only 4 or 5 off by shell moulding, but these are exceptional. For components required in large numbers in low-melting-point alloys, die-casting offers severe competition. With alloys of higher melting point, such as copper-base alloys, cast iron, and steel, shell moulding is often well suited for the production of castings of superior finish. However, justification for shell moulding must normally be sought in terms of reduced finishing costs, since, usually, shell moulding costs are greater than those of sand moulding.

Plain, carbon steels can be shell moulded, although problems related to a poor surface-finish exist. The best way around this is probably to put the poor surface at a point where it will be machined off. Usually, such a finish appears repetitively at heavier sections, so that its position can be controlled. Alloy steels have associated with them the problem of surface carbon pick-up, though if an organic binder be used carbon pick-up will also be encountered with sand castings. Much alloy steel, however, nowadays is being shell moulded. Some alloy steels are difficult to machine and these present great advantages when shell moulded, though grain-size control and control of carbide-distribution has been, and to some extent still is, a problem.

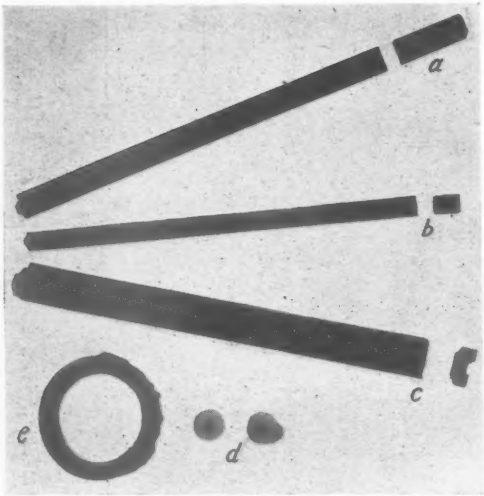


FIG. 17.—*Group of magnet castings made by the shell-moulding process.*

Finally, from the point of view of a foundry considering the use of shell moulding, the existence of plant already installed in a foundry for sand moulding is important.

Thus, it seems likely that shell-moulding installations may in the future be of two types. One type would be in the foundry where the main production is in terms of sand moulding. Here, the aim of shell moulding would be to give an improved finish on certain castings which would otherwise be made by sand moulding. The shell-moulding machine used here would be simple, and quite possibly not employed by any means full time. Its function would be to cater for the customer demanding close tolerances and finish, and who was prepared to pay for them. The second type of foundry, in much smaller numbers than the first, would be a shell-moulding specialist firm, fitted with automatic machines, where full advantage could be taken of this type of equipment, and of the opportunity for the improved control which it would offer.

Acknowledgments

The Author wishes to express his thanks to the following for their help:—Mr. J. G. Bailes, Mr. C. Robinson, Mr. H. Waterfield, Mr. C. Slinn, Mr. J. Bricklebank, Mr. D. Twigg, and Mr. A. Braybrook. He also wishes to thank the directors of the BSA group of companies and William Jessop & Sons, Limited, for permission to publish this work.

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Fullwood Foundry Extension

A new £23,000 extension at the works of Fullwood Foundry Company, Limited, Burnbank Road, Hamilton, was officially opened by Provost Mrs. Mary S. Ewart. It comprises a laboratory and baths. Among those present were Lord Clydesmuir, Sir John Craig, chairman and joint managing director of Colvilles, Limited, of which the foundry is a subsidiary, Sir William Marshall, and a large number of neighbouring industrialists. Provost Mrs. Ewart, who was introduced by Mr. John Scott, general manager of the foundry, said the foundry was the oldest in the burgh. She congratulated Sir John on his foresight in having the extension erected, and hoped that the co-operation between the town council and his firm would long continue.

Later Sir John Craig said they had witnessed what could be termed a dual enterprise. Industry still depended a great deal on manpower, and he hoped that the men would get a certain amount of pleasure out of working for the firm. An important factor in their development was the research work carried out, and, with the new laboratory, they could constantly and unceasingly improve their work.

Team work was the road to success. A great deal of money had been spent on the new extension and he did not intend denying it was hoped to get it back in due course. If they all worked together as a team, then it would be a pleasure to work in the foundry. It was true of life that you were either going forward or going back. If they wanted to seek to develop the foundry to the best possible extent, then they had to go forward.

The baths, which were erected at a cost of £16,000, provide accommodation for 100 men. On entering after work the men may first clean their boots with an electrical machine. They then proceed to the bath-house proper, where each man is provided with a locker for work clothes and one for clean clothes. A special ventilating system carries warm dry air, bearing a germicidal vapour through all lockers. Individual cubicles, each with thermostatically-controlled showers, are conveniently positioned.

Washing facilities, footbaths and an ambulance room are also provided, and the whole building is heated by hot air which has been filtered. Each individual locker is given a supply of this heat to ensure that any damp clothes are quickly dried. Inside the bath-house a number of extraction fans ensure that any steam is quickly dispersed.

The laboratory has been erected above existing offices and provides the most modern facilities for such a building. Heating is again by warmed and filtered air and is passed into the laboratory through ducts. A fume cupboard has an independent air extraction ensuring that no possible fumes permeate the laboratory. All the benches are of teak and the floor is of hardwood. The walls are tiled with special tiles to ensure easy cleaning. A small electric automatic hoist is provided to allow acids to be conveyed from the ground floor to the first floor without any possible chance of accident. Special rooms are provided for balances and storage. The approximate cost of the laboratory is £7,000.

Recent Developments in the Use of Plastics in the Foundry*

By P. G. Pentz, B.Sc.†

In the use of synthetic resins to bond sand for making solid foundry cores, new developments are to be found mainly in refinements of the resins —still chiefly u.f. and p.f.—and in methods of securing rapid cure, thus taking full advantage of the intrinsic properties of these thermosetting materials. Techniques used include high-frequency heating and, more recently, blowing of resin/sand mixture into a heated corebox. The rheology of resin-bonded sands has been investigated and the results obtained should assist in overcoming core-blowing problems.

Hollow-shell cores with many advantages over solid cores are coming into prominence as an offshoot of the shell-moulding process, being made possible by the advent of non-segregating (pre-coated) resin-bonded sand. Various methods and specialized equipment have been developed for making shell cores, using simple dump/shake-out, blow/suck or limited-blow techniques. Economies are obtained in material costs, production time and fettling costs (through improved casting finish), consequently, a rapid extension of shell core production is envisaged.

Pre-coated Sand

The use of such resins in pre-coating sand for shell moulding has received much attention. Several methods of pre-coating sand have been proposed but only the FELL process has been used on any substantial scale in Britain. Advantages of pre-coated sand for use in making shell moulds, in addition to the obvious absence of segregation which the term " pre-coated " implies, are discussed in relation to alternative shell-moulding materials. The rapid development of shell moulding in British foundries during the last year or two is attributed to the availability of automatic or semi-automatic shell-moulding machines, a clarification of the Patent position, and the wide dissemination of knowledge and experience through the foundry industry.

The translation of shell moulding from semi-laboratory development work to full-scale production has brought into focus problems which were previously unrecognized except perhaps in the USA where the process came earlier into large-scale use. Minor differences between grades of resin are becoming significant through their influence on such production variables as investment and curing cycles. Health problems associated with dust from the fine silica sand, and to a lesser extent the powdered resin, claim serious attention, and point to the substitution of the apparently innocuous pre-coated sand wherever possible. The need for recovery and re-use of shell-moulding sand has become apparent in consequence of the limited availability of new sand in the quality required. More rapid and flexible methods of securing half-moulds are needed.

Other Applications

Among the smaller applications of plastics in foundry work is the use of thermosetting resins, normally p.f., for improving the surface of conventional green-sand moulds and so obtaining better casting finish. Furane resins have been found surprisingly inferior to phenolics for this purpose, but their outstanding heat-resistance has been put to good use in making cheap core carriers for moderate runs. The possibility of casting patterns in furane resin compositions is being explored with a view to their use in place of metal patterns for shell moulding on short runs. For patterns and coreboxes used cold, cast epoxide resins hold great promise and are being actively investigated.

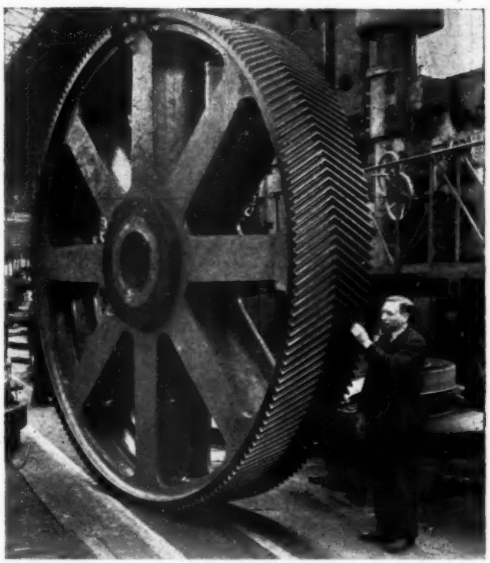
* Summary of a Paper to be read at this week's Plastics Conference.

† Technical sales manager, Leicester Lovell & Company, Limited.

David Brown-Jackson's Heaviest

Weighing 14½ tons, the double-helical gear shown in the accompanying illustration, was recently cast and cut by David Brown-Jackson, Limited, of Manchester. Destined for a South African sugar mill, it is the heaviest wheel ever supplied by the company as a one-piece casting. It has been supplied to Mirrlees Watson Company, Limited, to replace a lighter gear made in 1931 by David Brown-Jackson for a sugar-cane crushing plant. The new wheel is 12-ft. dia., has 187 teeth of 1¼ d.p. and a face-width of 26 in. The order also included the cutting of the mating forged pinion. These replacements were required to enable the South African plant to convert a two-roller crusher to three-roller capacity.

Double-helical gear, a steel casting weighing 14½ tons, cast and cut by David Brown-Jackson, Limited.



Steel Industry's Progress

Board's First Annual Report

Established under the Iron and Steel Act of 1953, the Iron and Steel Board took up its duties on July 13 of that year. On May 24 the Board published its first annual report, covering the period July 13, 1953, to December 31, 1954. It indicates the manner in which the board has during the first 17½ months of its existence carried out the duty of exercising a general supervision over the iron and steel industry with which it was entrusted under the Act.

Much of the ground covered by the report has necessarily been surveyed before. Development, particularly, was dealt with fully in the special report submitted to the Minister of Supply in February (*Foundry Trade Journal*, March 10, 1955, p. 265). The annual report supplements this special report and includes details of development schemes to which consent has been given during the period under review.

The schemes approved cover a wide range of activities and relate not only to the replacement and extension of capacity for traditional products, but to the introduction of capacity for new products. The most noteworthy are Colvilles, Limited, for the extension of pig-iron production and the modernization of steelmaking in Scotland; Dorman Long (Steel), Limited, for the revision of mill plans to give greater flexibility in the products to be rolled; Patent Shaft & Axletree Company, Limited, for the modernization and extension of steelmaking capacity and the installation of new primary rolling and finishing plant including a four-high plate mill; South Durham Steel & Iron Company, Limited, for facilities for the manufacture of large-diameter pipes in greater lengths than have hitherto been made in this country and which are in demand overseas; Steel Company of Wales, Limited, for finishing plant for production of tinplate; United Steel Companies, Limited (Steel, Peech & Tozer branch) for the installation of a medium width strip mill; Stewarts and Lloyds, Limited, for the installation of an oxygen producing plant; John Summers & Sons, Limited, for additional steelmaking capacity and other improvements designed to increase the supply of steel sheet.

Demand and Supply

Discussing the supply situation, the report points out that during the first half of 1954 there was no general shortage of steel, but in the second half of the year demand increased more rapidly. Demand has been maintained and is now strong for most steel products. Home production is being expanded as rapidly as possible to meet the increasing demand. It is estimated that production this year will reach 19,500,000 tons. The possibility of exceeding this figure and of obtaining the necessary raw materials to do so is under constant review.

Although the difficulties in the supply of finished products last year were very real for individual consumers, they were none the less marginal, the report states. This is apparent from the fact that consumers' stocks remained practically unchanged during the first half of the year and fell by less than 100,000 tons during the second half in relation to a total stock of rather more than 3,000,000 tons.

Imports purchased centrally for use in the finishing sections of the industry this year are expected to be the equivalent of about 600,000 ingot tons. The total which consumers themselves will bring in cannot accurately be forecast, but is expected to be about 750,000 ingot tons. The major imports are likely to be sheet and tinplate. It is for these products that the recent upsurge in demand has been most marked. So far as can be judged at present it is thought that total imports of all forms of steel will be equivalent to upwards of 1,350,000 ingot tons. The total supply of steel in 1955 is thus expected to be about 1,800,000 tons above 1954, against an increase in supplies of 700,000 tons between 1953 and 1954 and an average annual increase over the past five years of 420,000 tons.

A description is given of the general review of iron and steel costs and prices which was one of the first tasks undertaken by the Board. The net effect of price changes made last year was to increase the general level of steel prices at the end of 1954 by approximately 3 per cent. above the level at the end of 1953. A chart in the report shows that steel prices in the United Kingdom are still well below home prices on the Continent and in the United States.

ICI Expansion

Expenditure by Imperial Chemical Industries, Limited, on its construction programme during 1954 amounted to £34,000,000, making a total of £190,000,000 expended on new fixed assets since the end of the war. Outstanding commitments are approximately £18,400,000 for the company and £21,200,000 for the group. Physical fixed assets of the group are shown at £305,000,000, an expansion of some £41,000,000 over the previous year's figure. Total group assets increased last year by over £84,000,000 to £523,000,000.

Commenting on the company's report, Dr. Alexander Fleck, the chairman, said that the board was determined "to oppose by every proper means within its power any attempt to nationalize the company or any part of it." Any form of nationalization, he said, could only do damage to the company's work at home and abroad, be harmful to industry in general, and thus be detrimental to the whole national economy.

Reasons for Identical Tenders

Replying to Australian reports that United Kingdom electrical suppliers had been guilty of trying to exploit the market over certain large contracts, a spokesman for the makers of British transformers has explained that the eight identical British tenders of the 20 submitted for equipment for the Snowy Mountains project represented a united effort by the British manufacturers to reduce prices to a minimum to meet world competition.

References to "price rings" were unjustifiable, he declared. In this instance the contract went to another bidder. The spokesman went on to say that to attribute the loss of such orders to price rings was misleading, because in most instances British tenders had been successful.

THE AUSTER AIRCRAFT bought by the United Steel Companies, Limited, to link the Workington Iron & Steel Company branch with those of the Sheffield region was in operation for the first time on May 24, when it brought the Workington office manager, Mr. W. McGregor, to a conference in the city.

PRODUCTION of railway-engine wheels at the Steel, Peech & Tozer Branch of the United Steel Companies, Limited, was at a standstill for a few days, when a breakdown occurred in the wheel mill shop. A cylinder broke in a dishing press, and a team of men worked 12-hr. shifts to repair the machine.

Cores and Moulds by the CO_2 Process

*London Discussion of Mr. A. Talbot's Paper**

The subject matter of an ordinary meeting of the London branch of the Institute of British Foundrymen, held in the Waldorf Hotel, London, on March 30, with Mr. W. Wilson in the chair, was "Cores and Moulds by the CO_2 Process."

MR. WILSON, introducing the lecture, said the subject was a controversial one and members would hear a controversial lecturer in Mr. A. Talbot, who had brought with him Mr. Johnson from the Birmingham branch.

Opening the discussion after the Paper had been presented, MR. A. AUGSTEIN said he was particularly pleased to have his own belief confirmed when Mr. Talbot called this a revolutionary process. He himself and his colleagues had been interested in the CO_2 Process for many years, and he only wished he had given such an excellent lecture, when in 1952, he started the ball rolling by demonstrating the process for the first time in its history in public at the Battelle Institute, Columbus.

He had no criticism to offer apart from one or two small matters, one concerning over-gassing. Perhaps, the possibility of over-gassing depended on the grade of binder being used, as there were grades which could be over-gassed and others which could not, even if the pressure and time were considerably increased from Mr. Talbot's basic ratio of 20 lb. pressure for 20 sec.

The lecturer had said he was using a sand mixture containing 4 per cent. gas binder and 1 per cent. pelleted pitch, but he (Mr. Augstein) would have thought that the pelleted pitch would have darkened the mixture and the cores made from it. Yet, although some of the cores passed around for inspection were, in fact, dark, and indicated the use of pelleted pitch, others were very light in colour and did not seem to contain pitch. Was that a correct conclusion?

MR. TALBOT agreed that some of the cores were white and they were without pitch, but contained wood-flour instead. The dark cores had got pitch in them. He had had some made without pitch because, being purely for demonstration purposes he thought they looked better and were more attractive. But, even the white cores were perfectly sound and usable and he would guarantee as good a casting from them as from those containing pitch.

Sand Reclamation

MR. A. A. MATTHEWS asked if Mr. Talbot reclaimed his sand.

MR. TALBOT said he had never done so with the oil-sand process and did not do it now either. He could buy new sand cheaper than he could reclaim the old.

MR. MATTHEWS thought new sand must be an expensive item when many tons of castings of the size shown were being produced. Surely the solution was to reclaim the sand somehow, as was usual in the shell-moulding process?

MR. TALBOT said it was not worth while to spend money on reclaiming when sand was so cheap.

MR. LESTER said he was very indebted to Mr. Talbot. His was only a small foundry, but Mr. Talbot had been only too willing to help in any way he could. He had recently taken a core to Mr. Talbot to be made by the shell process. It was a tricky impeller and very thin—one of a class his firm could not possibly make for themselves—but Mr. Talbot said he had something better than shell coremaking to offer, and proved his point. Within a week, he himself had made three successful castings using the CO_2 process.

In answer to Mr. Matthews, his firm were reclaiming some of their sand. They had found that the CO_2 did build up a solid on the grains of sand which prevented its use a second time. But by leaving it in the yard for a month or two they had found they could treat it successfully. On an average, some 50 per cent. was reclaimed.

MR. WILSON, the chairman, asked how long the sand was left in the open. Some of his sand after three months was still in lumps.

MR. LESTER said that by crushing the sand first, effective results had been obtained.

MR. TALBOT asked what was the good of saving storage space if it was going to be filled up with great heaps of sand while waiting for it to disintegrate? His firm had had some cores which had stood in the open for three months and had not disintegrated. With a CO_2 core he had found it could be wetted and dried and the process repeated and still used satisfactorily at the end. However, crushing the sand did help, but he wondered if the cost was justified.

MR. LEVY thought the question of reclaiming sand was easily solved. If one was doing a big job one just dropped the big lumps in as filling and that solved that problem, one used a high percentage of the discarded sand and there was no difficulty. There were one or two points he would like to make on strickling. In his foundry it was found that when the CO_2-prepared sand was strickled at the corners it was very rough and it needed a certain amount of control to finish it. What did Mr. Talbot do to get a reasonable surface, did he trowel it? His next point concerned break-down. Some fair-sized moulds had been made in his foundry and all of them had had thicknesses from dimensions which were quite thin to about 1¼ in. (to be used for cast iron). They could not use a 1-in. crowbar on those and breakdown

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did become tedious because the sand was rather tough.

Break-down

MR. TALBOT said if a long shape was made the cores had to be rubbed to fit. With the CO_2 Process he would ask "Why worry?" The same principles applied. Going back to the question of thin sections and using a crowbar. A crowbar could not be used on some of the examples he had shown. He did not propose to enter into any controversy about break-down because he had never had trouble with it. Perhaps Mr. Johnson might be able to tell members more about it. He had more experience.

MR. JOHNSON said he could only give general observations on break-down. He had found that troubles with break-down, each case had to be dealt with according to the need of the moment. He had found that in some cases the Process could make break-down extremely difficult, but there were certain basic rules to be followed. The first was the amount of binder used. The mixture used with recommended binder percentage gave the strongest core that could be obtained by the method. But in some cases it might well be that the break-down could be improved by the use of less binder, and although the core would not be so strong it would still be quite suitable.

Second, there was the question of pelleted pitch. He thought it needed to be handled with caution, depending on the size of the core in relation to the section of the mould. It was quite suitable for non-ferrous metal and cast iron. One-and-a-half per cent. was perhaps as much as could be normally used with safety. In some cases it might have to be decreased from 1 per cent. to a half per cent. or even a quarter on particular jobs, as the break-down, instead of improving, got more difficult.

It had been experienced that break-down improved if the casting was allowed to go cold rather than being knocked-out while still hot; that was typical of every mould he had tried. It was noticeable with the CO_2 process that a poor knock-out whilst hot was associated with a very hard and white sand adhesion to the casting face, whilst if the casting was allowed to cool before being knocked out this adhesion was black and soft and easily removed. There were limits to each of those remedies, but if they were borne in mind, founders would get as near as was possible to the perfect break-down with that material.

The only other possibility was hollowing out the core, particularly in cylindrical cores surrounded by a heavy section of metal. A 1-in. hole in the centre of a 3-in. core did help very much. Whereas if made solid it would be extremely difficult to get it out.

MR. ROBINSON, referring to Mr. Levy's observations, said he had found that if it was necessary to sleek, dipping the trowel in paraffin did give a smoother finish, and helped to prevent clogging of the tool. He had generally achieved a good skin without coating, using 1 per cent. pitch.

His firm had also cast a solid block of iron weighing 9 cwt. and had used CO_2 sand as one would use normal facing sand. Rather more was needed, perhaps, up to 3- to 4-in. layer round the pattern, depending on size and weight, with backing sand rammed up in the usual way. He had found it was necessary, in some cases, to key the CO_2 mix when using it in this manner, by the use of sprigs or other stiffeners inserted horizontally into the backing sand, otherwise there was a tendency to separation of one from the other on pattern withdrawal. The cost of stove drying and the incidence of scabbing had been substantially reduced. His experience had been that with several copper-base alloys in general use, including aluminium-bronze and manganese-bronze, aluminium alloys and cast iron, there was 100 per cent. success from a casting point of view. He was, however, still experiencing difficulty with collapsibility, and was awaiting the results of experiments in this direction.

Type of Sand

MR. ROBINSON also pointed out that he was using a mixture of Redhill F and sea-sand, which was different from that used by Mr. Talbot. He would like to know if this was, perhaps, inadequate for best results. Would he be well advised to use Erith silica as Mr. Talbot recommended?

MR. TALBOT said he would prefer not to comment on sand mixtures, because his experience only dated from the previous August, which was insufficient.

MR. PIERCE asked whether Mr. Talbot would assert that the CO_2 process could be used 100 per cent., or anywhere near 100 per cent., on small non-ferrous work making small non-ferrous cores which could be taken out of the box and inserted straight away. Did he consider it would be economical for a foundry to adopt the Process for that type of core?

MR. TALBOT said he made all his cores by the CO_2 process, but he would not like to advise everyone to change over. There were so many factors to be taken into account. Mr. Pierce might already be well equipped to dry small cores and would have to justify his expenditure on a new system. He would be very loath at that stage to say the CO_2 process was cheaper for small cores than other processes. His foundry made many small cores and it did not even use any gas—it utilized the CO_2 of the air, which was quite sufficient for cores of the small type which he had passed round. Such small cores would dry in the air providing one could afford to wait for twenty minutes. If conditions demanded immediate use then a whiff of gas was sufficient. Though it was easy to work out the gas : time ratios, a foundry would soon find out what amount of gas was required.

He would not suggest that on very small cores the Process offered advantages for the man who already possessed modern drying equipment. He recommended it to the founder who had had to refuse work because he could not handle the cores required. It would enable him to increase his range and widen his activities.

MR. WIZARD said as the manager of a small foundry he would not dream of turning completely over to the CO_2 Process, but he had seen things that evening which were so interesting that he thought he would have to examine the Process more carefully, with respect to the drying and handling of the large cores. What difficulty did Mr. Talbot get with bulk drying of sand, and how necessary was it?

MR. TALBOT pointed out that his recirculation-type oven was still working full time on the drying of moulds. With regard to drying the Erith silica sand he did the same as anyone else would do. He had no dryer so he put the sand in the bottom of the oven and drying did not cost anything!

He did not suggest anyone should change over, but that founders should look at the matter from the angle of anyone starting from scratch. Under such conditions one had to decide if one should buy a drying oven or use the CO_2 Process.

He no longer dried any cores and on some of the firm's jobs the cores were fitted into the moulds before they went into the drying oven. There was nothing to worry about in that. The CO_2 core would not burn, even if left in the oven for months! A mould had been dried many times over without the core deteriorating; it appeared that heat had no effect on a CO_2 core.

Vote of Thanks

THE CHAIRMAN, as time was short, took the unusual course of proposing the vote of thanks from the chair, and said he was sure Mr. Talbot was very happy to see such a very large attendance, and to note that his audience included members from other branches. These guests, as well as the students who had come along, were all very welcome. Their presence and the discussion clearly showed their appreciation, and he felt he was really speaking on behalf of the whole assembly when he thanked Mr. Talbot very sincerely for his paper.

MR. TALBOT, replying to the Chairman, said he felt very humble being there because the credit of his paper belonged to a lot of people. He was only the mouthpiece for his colleagues and people who had worked with him. They had been able to try out their ideas together and freely criticize them. Particularly he would like to thank his directors for the encouragement they had given him in connection with that process.

With regard to the film of the process, he would very much like, if it was thought to be of any value, to pass it into the keeping of the Institute of British Foundrymen for the use of all.

It had been a great pleasure to have been the mouthpiece of his colleagues and helpers and he thanked the members for the attentive hearing they had given him.

This concluded the meeting.

EXOTHERMIC FERRO CHROMIUM in briquetted form is now being produced for the first time in the United Kingdom by British Electro Metallurgical Company, A Division of Union Carbide Limited, in their Wincobank, Sheffield, plant.

Company News

PATERSON ENGINEERING COMPANY, LIMITED—The volume of work in hand constitutes a new record, according to the chairman, Mr. J. V. Sheffield. Orders received since the end of the year continue the trend.

PLESSEY COMPANY, LIMITED, general engineers, of Ilford (Essex)—The directors have declared an interim dividend of 12½ per cent., less tax, on the £800,000 ordinary capital in respect of the year ending June 30. For the previous year an interim of 10 per cent. was paid on £500,000 ordinary, followed by a final of 10 per cent. on the present capital.

PEGLERS, LIMITED, brassfounders, engineers, etc., of Doncaster—With net profits more than doubled, at £289,380 after all charges and taxation, compared with £114,557 in the previous year, the directors recommend an increase of 5 per cent. in the dividend in respect of the year ended March 31. The dividend on the £836,813 "A" and "B" ordinary shares is 1s. per 5s. share, or 20 per cent., less tax, against 9d. per share, or 15 per cent., less tax, which absorbs £96,233 against £69,037.

JOHN THOMPSON, LIMITED, combustion and general engineers, of Wolverhampton—In addition to a 10 per cent. final dividend, as forecast last February, the directors are paying an extra 5 per cent. bonus, "warranted" by the 1954 results. All eligible staff and workpeople are to receive a bonus of one week's basic pay, which is approximately equal to the 5 per cent. bonus to stockholders. Group turnover was over £17,345,000, or almost £3,000,000 above the 1953 level, and trading profits advanced from £1,472,760 to £2,049,591.

CROFTS ENGINEERS (HOLDINGS), LIMITED—The directors are calling an extra-ordinary meeting at Bradford on June 7 in connection with the proposed free scrip and rights issues. The proposals are intended to increase the capital to £2,500,000 by the creation of 4,000,000 additional 5s. ordinary shares; to capitalize £400,000 of reserves in a one-for-two scrip issue; and to vary the ordinary voting rights to give preference shareholders a fairer proportion of votes. The proposal is two votes for every £1 of preference and one vote for every 15s. of ordinary capital.

J. BROCKHOUSE & COMPANY, LIMITED, dropforgers, ironfounders, spring manufacturers, etc., of West Bromwich—The company is maintaining its interim payment on the £3,208,170 ordinary stock at 2½ per cent. for the year to September 30, 1955. A 3½ per cent. final made a 6 per cent. total for 1953-54. The directors report that sales and profits of the company for the half-year to March 31, 1955, continue to show an improvement, the relative value of both being 20 per cent. greater than for the corresponding 1954 period. The order-book shows a substantial increase and is continuing to grow.

HATTERSLEY (ORMSKIRK), LIMITED, engineers and brassfounders—The preliminary statement shows that both group net profits and the ordinary distribution are doubled for the year ended March 31. Net profits, which include the results of the subsidiary, Beck & Company (Meters), Limited, for a full year, against five months only for 1953-54, are shown at £299,823, compared with £149,842, struck after an increased tax charge. A final dividend of 15 per cent., plus a 7½ per cent. bonus, is recommended, making 30 per cent. for the year on the existing £500,000 equity capital, the same total rate as paid for 1953-54 on £250,000 before the 100 per cent. free scrip issue. The total, however, did not include any bonus.

Pig-iron and Steel Production

Statistical Summary of March Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in March, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in March, 1955, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	Price Index, 1938 = 100.			Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy),			
	I. & S.	Coal.	All comdts.						Imports.[1]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[2]
1953	260	350	323	304	207	237	215	188	18	339	262	962
1954—Oct. ..	265	365	324	304	237	236	231	210	3	374	292	973
Nov. ..	266	372	326	302	241	341	235	211	6	377	303	900
Dec.[3]	267	372	331	301	236	240	234	196	7	355	285	831
1955—Jan.	268	373	333	303	243	240	236	213	11	381	298	828
Feb. ..	269	373	334	315	246	242	242	220	17	394	314	812
Mar.[3] ..	270	374	331	322	239	244	241	225	28	395	—	807

TABLE II.—*Production of Steel Ingots and Castings during March*, 1955.

District.	Open-hearth		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	4.2	13.6(basic)	2.0	0.2	18.9	1.1	20.0
Lancs. (excl. N.W. Coast), Denbigh, Flints and Cheshire	1.3	29.9	—	2.3	0.4	32.5	1.4	33.9
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	41.1	—	—	0.2	41.1	0.2	41.3
North-East Coast	1.5	75.1	—	1.4	0.4	76.4	2.0	78.4
Scotland	2.9	41.0	—	1.7	0.6	44.3	1.9	46.2
Staffs., Shrops., Worcs. and Warwick	—	18.5	—	1.2	0.8	18.5	2.0	20.5
S. Wales and Monmouthshire	5.3	80.3	5.9 (basic)	1.3	0.2	92.2	0.8	93.0
Sheffield (incl. small quantity in Manchester) ..	9.3	32.5	—	11.7	0.5	52.0	2.0	54.0
North-West Coast	0.1	1.5	5.4 (acid)	0.5	0.1	7.5	0.1	7.6
Total	20.4	324.1	24.9	22.1	3.4	383.4	11.5	394.9[3]
February, 1955	20.7	323.2	25.5	21.5	3.3	383.1	11.1	394.2
March, 1954[3]	21.4	300.8	20.9	18.0	3.7	354.0	10.8	364.8

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product.	1953.	1954.	1954.	1955.	
			Feb.	Jan.	Feb.
Non-alloy steel:					
Ingots, blooms, billets and slabs[4]	4.7	5.1	5.3	5.2	5.1
Heavy rails ..	8.7	9.6	11.6	9.8	10.1
Sleepers, etc. ..	2.2	1.9	1.8	1.4	2.5
Plates 3 mm. thick and over ..	46.5	47.0	51.8	43.7	47.7
Other heavy prod. ..	43.9	45.8	47.7	47.8	50.9
Ferro-con. rods, etc.	5.1	5.9	4.8	7.1	6.5
Wire rods and other rods	15.6	19.7	18.6	23.1	23.5
Light-rolled prod.	44.2	41.2	42.7	45.1	48.3
Bright steel bars ..	6.7	6.3	6.3	7.4	7.9
Hot-rolled strip ..	18.8	21.7	21.0	24.3	24.4
Cold-rolled strip ..	5.2	7.0	7.0	8.1	7.8
Sheets, incl. coated	34.1	38.8	39.4	43.8	44.9
Tin, terneplate and blackplate ..	14.9	16.8	18.0	18.0	16.6
Steel tubes, pipes..	20.1	20.0	19.0	21.3	22.4
Tube, pipe fit'gs.	0.3	0.4	0.4	0.4	0.4
Tyres, sheets, axles	4.4	4.7	4.8	4.6	5.7
Forgings (excl. drop forgings) ..	3.1	2.6	2.9	2.4	2.7
Steel castings ..	4.0	4.0	4.1	4.1	4.1
Tool and magnet steel	0.3	0.2	0.3	0.3	0.3
Total	282.8	298.7	308.4	317.9	331.8
Alloy steel	13.7	13.2	13.8	14.9	15.8
Total deliveries from U.K. prod.[5] ..	296.5	311.9	322.2	332.8	347.6
Add: Imported finished steel ..	6.8	5.0	9.0	10.7	13.0
	303.3	316.9	331.2	343.5	360.6
Deduct: Intra-industry conversions[6] ..	42.6	41.5	42.4	46.3	48.2
Total net deliveries of new material ..	260.7	275.4	288.8	297.2	312.4

TABLE IV.—*Production of Pig-iron and Ferro-alloys during March*, 1955.

District.	Furnaces in blast.	Hematite.	Basic	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	26	—	18.2	27.2	1.4	—	46.8
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	6	—	14.2	—	—	1.4	15.6
Yorkshire (excl. N.E. Coast and Sheffield) ..	—	—	—	—	—	—	—
Lincolnshire ..	10	—	36.9	—	—	—	36.9
North-East Coast	22	4.7	47.1	—	—	1.4	53.2
Scotland	9	0.4	16.4	2.4	—	—	19.2
Staffs., Shrops., Worcs., and Warwick ..	7	—	9.7	1.5	—	—	11.2
S. Wales and Monmouthshire	10	4.8	30.9	—	—	—	35.7
Sheffield ..	2	—	3.4	—	—	—	3.4
North-West Coast	8	17.2	—	0.1	—	1.4	18.7
Total ..	100	27.1	176.8	31.2	1.4	4.2	240.7[3]
February, 1955 ..	99	27.1	179.2	30.4	1.1	3.9	241.7
March, 1954[3] ..	105	27.6	168.5	30.4	0.6	3.8	230.9

[1] Weekly average of calendar month.

[2] Stocks mainly ingots and semi-finished at the end of the years and months shown.

[3] Five weeks, all tables.

[4] Other than for conversion into any other form of finished steel listed.

[5] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.

[6] Material for conversion into other products also listed in this table.

Making a Given Casting—First of a Discussion Series Arranged by the IBF West Riding of Yorkshire Branch

The selection of a problem casting—the cylinder-liner shown in Fig. 1—posed complicated questions to be answered by panels of expert foundrymen at the West Riding of Yorkshire IBF meetings this session. The following remarks were preliminary reactions to the hypothetical receipt of an enquiry for the job. In the latter part, cost considerations were introduced by Mr. H. Forrest, but it was obvious that more time was needed for deciding upon optimum methods of manufacture before the panel could formulate definite views.

The West Riding of Yorkshire branch of the Institute of British Foundrymen scheduled several evenings this session to the study of one casting—the design of which is shown in Fig. 1. For this purpose a panel was formed of those skilled in various aspects of foundry practice. The first session started with the receipt of the enquiry for the job under consideration—a water-cooled cylinder-liner.

MR. FORREST first queried the wisdom of accepting an order for such a component but said if it was accepted, the steps to be taken would be followed through logically.

MR. ALLARD, after a quick look, suggested that it should be cast on end with the flange at the bottom using a dry-sand mould. He would construct a core in such a way that pencil runners were round it at the top, and the ends of the casting were formed by the core. A header of 2 in. would be put on one end. He would ask for the pattern to be in two halves. The pattern would be rammed on its side, two halves made, the mould closed and turned on its side to cast it with an open end box.

MR. MCPHERSON said that in order to hold the core in position in the mould it would be necessary to fasten down the core. The only place where this core was actually resting on the outside of the mould was at the flange end. Other points where it went through were the small ports from the jacket of which there were three in number, and these were 1¼ in. dia. He was afraid the draughtsman had forgotten to indicate machining there. That core would be held in three points and there must be at least ¼ in. machining. The ports were coming through at very curious angles which meant that these cores were going to have to be made in four sections in order to be able to slip them through the jacket. As the mould was seen from the horizontal position, there was a number of cores to set in awkward positions and with prints which did not offer positive location. Unless one could fasten all these securely one could not turn it on its end. [Here, Mr. McPherson illustrated in detail how he would mould and core the job, referring from time to time to the drawing (Fig. 1).]

MR. SIMPSON, speaking from a patternmaking point of view, said it could hardly be cast with flange down. To him it would appear that this needed casting on its side and it would be difficult. There required to be much thought as to how one would fasten the cores. As a patternmaker he would ask the foundry for their views on the way it was to be made. Incidentally so far as he was concerned, he had to make the pattern and if the foundry did not get a good casting he would be blamed.

MR. ALLARD, disagreeing with Mr. Simpson, said he would cast it on its side.

MR. MCPHERSON said that, but for the six ports which go through at an angle, one could do that, but unfortunately one could not get through any other way than to slip two cores into the bottom and then one had to set the same on the top and one could not fasten these cores into the top part. Another point was that one must get a vent off at every point possible.

MR. COLLINSON suggested everybody was wrong, as the ports ought to be made in one piece with the jacket cores. If one made the ports that go into the centre part of the jacket core there were none of those difficulties. If the interior openings were all joined up by an internal ring, the main core could be set on this. He thought it should be cast with the flange at the top, but if that were done there would be a great deal of trouble.

MR. FORREST pointed to the extreme fragility of the port cores.

MR. SIMPSON said it would be necessary to make the job in such a manner that one could seal off the vents. The vents were one of the vital parts of this job, if they were not sealed off trouble would immediately ensue.

MR. FORREST suggested the retention of the drawing and that in the time between now and the next meeting it be given some thought and see if the opinions of the panel could be bettered. There was always an alternative way. It was not an easy casting to make from many aspects and it would be noticed the core sections there were to deal with, the need for adequate venting, the fact that it had to be machined all over; the bore had to be scupulously clean, also eventually it would be tested at 100 lb. per sq. in., using paraffin as a testing medium, which, as was well known, was very searching and precluded the tendency to rusting up. He suggested that the method of casting was left until members had studied it. In the meantime they would pass on to a method which could be applied in arriving at some idea of the cost of this job.

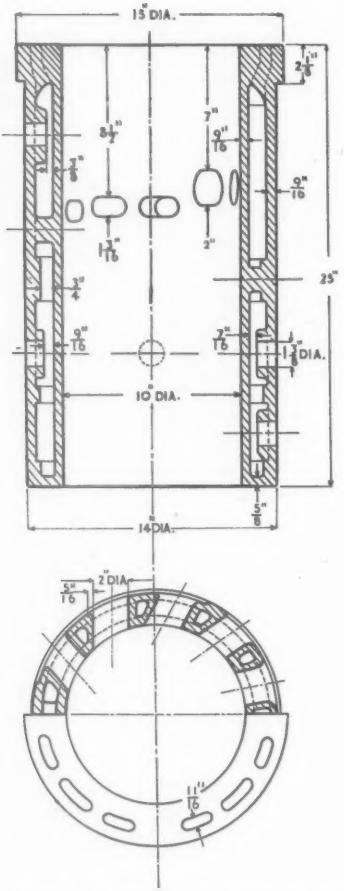

FIG. 1.—*Elevation and plan views of the hypothetical casting, the various aspects of manufacture of which were discussed.*

Costing

MR. KELLY outlined a method of arriving at the cost and illustrated this on the blackboard.

MR. FORREST pointed to the futility of looking at a job and more or less guessing a figure of so much per cwt. It just did not work out in cases like this and there must be some regard to the risks and contingencies which must be allowed for in a casting of this nature. He thought this example would go to show that there was a proper basis for costing, and in this particular case there was a fair example. He did not think they could go much further at the moment, and at the next meeting Mr. Simpson would indicate how he would propose to make this pattern so that Mr. Allard and Mr. McPherson could make the cores. He invited criticism and any helpful comments from the members so that they could then get down to the real bones of this problem and everybody would have learnt something.

MR. A. COLLINGE, referring to the drawing, asked where the 2-in. dia. hole went to.

MR. SUNDERLAND pointed out that it was not a round hole, it was elongated—an oval hole, or slot. It needed specifying as a diameter.

MR. COLLINGE said there was also a line which was about ⅛ in. below the machined surface which was not shown on the section on some drawings.

MR. FORREST said that was a relief on the skirt to provide boring on the portion where the liner fitted into the crank case. It was intended to machine the relief. It would be a perfectly smooth barrel on the outside.

MR. COLLINGE said the top ports were shown on the end view; it was obviously 2 in. dia. It would seem that all the ports were to be different in construction.

MR. SUNDERLAND said all those ports were drawn as they would be seen on a curved surface.

MR. COLLINGE said the port on one side was the boss on the inside; were they similar, *i.e.*, the same as the one on the top?

MR. SUNDERLAND said there was a point which might conflict in members' minds. On this drawing there were two ribs, these did not go all the way round. There were not two separate chambers at top and bottom.

MR. BOLTON, speaking as a metallurgist, asked whether the customer specified any particular hardness. Should it be assumed there was some other information?

MR. FORREST: It was assumed the foundry, which was to be responsible for the job, would provide material which was dense. which had an average Brinell hardness of about 190 to 200, and the foundry would not be tied down too closely in the first instance, provided they delivered a sound casting. It was assumed sound castings free from porosity were required.

MR. FORREST, in answer to a query, said the pattern equipment must be suitable for batches of 100 off.

[Here the matter was left for further consideration by members at successive meetings, when questions of patternmaking, moulding, coremaking and metallurgical aspects would be considered in greater detail.]

Nickel Release for US Industry

United States industry will benefit this month from the Office of Defence Mobilization's announcement that an additional 900 tons of nickel will be made available at market price to relieve the metal shortage. The nickel will be diverted to industry instead of going to the stockpile.

The importance of the level at which the US Government continued to take nickel for defence and stockpile purposes was stressed last week by Sir Ernest R. Canning, chairman of W. Canning & Company, Limited, electroplaters' engineers, of Birmingham. Nickel supplies had been causing anxiety and there was not at present sufficient to meet the demands of the electroplating, steel, aircraft, and other industries.

Recent Law Cases

£1,125 Damages for Loss of Eye

After an absence of nearly two hours a jury in the Court of Session returned a verdict in four sections, on each of which they were differently divided, and the effect of which was to award £1,125 damages to a Grangemouth labourer who lost the sight of his right eye in an accident at his place of work.

The plaintiff, Graham Taylor (29), of Burns Avenue, Grangemouth, who was employed by the Falkirk Iron Company, Limited, was nailing up packing cases on April 25, 1952, when a nail sprang back and struck his eye, blinding it. He averred that a consignment of cookers awaiting shipment were found to be damp and the defendants ordered that the cases be opened up and dried. The cookers were to be repacked in the same cases, using the same nails. The drying process, according to the plaintiff, rendered the wood hard, and the use of blunt nails dangerous. The defendants did not provide him with eye shields.

The company, which was sued for £3,000, denied liability, and maintained that the drying of the wood did not make it excessively hard. It did not admit the circumstances of the accident, and said new nails were available for the plaintiff's use. The accident, it was stated, was due to his own fault in failing to strike the nail squarely on the head.

By a majority of 10 to two, the jury found for the plaintiff, and by a majority of 11 to one assessed damages at £1,500. They unanimously found that the plaintiff was also partly to blame, and, by a majority of seven to five apportioned liability at 75 per cent. to the defendants and 25 per cent. to the plaintiff.

Foundryman Awarded £2,025

A foundry stoker, William John Williamson, of Iredale Crescent, Workington, was awarded £2,025 damages with costs in a civil action heard at the Cumberland Assizes at Carlisle before Mr. Justice Oliver. Williamson sued High Duty Alloys, Limited, Distington Foundry, Workington, for damages for personal injuries received at his work.

Mr. Crichton, for the plaintiff, said this was a matter only as to the amount of damages, liability having been admitted by the defendants. The plaintiff, who is 53, was employed by the defendants at their foundry. On August 2, 1952, he was shovelling ore into a furnace when he lost his balance while on a defective iron plate in front of the furnace. He fell, and as he did so he was struck by the shovel in the region of his stomach. The injury was one of very considerable gravity and it was attributable to the accident. The plaintiff was now working on a job at a reduced wage. Special damages had been agreed at £295. Mr. Justice Oliver said this was a very distressing case indeed. He gave judgment in favour of the plaintiff for a total of £2,025 with costs.

A FOURTH ORDER in connection with the Euston-Watford line of the London Midland Region has been secured by the General Electric Company, Limited, for multiple-unit train sets to replace existing rolling stock.

THE REPORT of the International Nickel Company of Canada, Limited, and subsidiaries for the three months ended March 31, shows net earnings in terms of US currency of $20,678,248 after all charges, depreciation, depletion, taxes, etc., equivalent after preferred dividends, to $1.38 per share on the common stock.

Shortage of Smokeless Fuel to Continue

There is likely to be a shortage of smokeless fuel for some years. A warning to this effect was given by Mr. Arnold Marsh, director of the National Smoke Abatement Society, during a lecture on "Smoke and the Law" to Yorkshire branch members of the Institute of Fuel in Sheffield. Mr. Marsh said that a reform in domestic fuels could only proceed at the rate of smokeless fuel becoming available on the market. In making smokeless fuel available there had been almost a vicious circle. Developments in production of solid fuel had been held back. At the same time there had been a fear of introducing new legislation, because there would be insufficient smokeless fuel.

What had to be done, Mr. Marsh continued, was to ensure that the circle started moving the other way round—to see that the establishment of smokeless zones encouraged the further production of smokeless fuel, which in turn would make further zones possible. But he warned his audience that it would be a long time before domestic smoke prevention could be applied to rural areas. An important change in public opinion, however, had started to break down some of the apathy towards the Beaver Report. Another problem would be concessionary coal for miners, he added.

Iron-ore Imports

Iron-ore imports in April, and the total for the first four months of this year compared with the corresponding period of 1954, are shown below.

From	Month ended April 30.	Four months ended April 30.	
	1955.	1954.	1955.
	Tons.	Tons.	Tons.
Sierra Leone	56,180	196,558	210,243
Canada	—	150,081	79,615
Other Commonwealth countries and Eire	312	15,008	4,812
Sweden	274,853	1,384,056	1,118,434
France	67,419	166,202	214,888
Spain	122,720	167,678	267,455
Algeria	208,454	715,326	738,668
Tunisia	74,790	174,196	223,484
French Morocco	26,750	102,457	87,529
French West Africa	67,747	201,106	178,917
Spanish Morocco	36,415	82,657	77,145
Liberia	38,000	71,859	104,087
Brazil	49,790	146,780	131,405
Other foreign countries	22,193	117,108	82,555
TOTAL	1,045,623	3,691,072	3,519,237

Newton, Chambers £1,000,00 Development

Before the board of Newton, Chambers & Company, Limited, Thorncliffe, near Sheffield, is the consideration of spending over £1,000,000 on development in the next two or three years, the chairman, Mr. P. G. Roberts, revealed at the company's annual meeting.

The company was making certain that it had the right sort of equipment and development department to ensure that when the opportunities which were coming to industry during the next 10 to 15 years arrived, it would be in the front and ready to take up those opportunities, declared the chairman.

News in Brief

THE FIRST CARGO—2,563 tons—of Russian pig-iron to arrive at Newport (Mon) was unloaded from the s.s. Verkhoyansk.

AEREX, LIMITED, Sheffield, has appointed F. H. Biddle, Limited, London, E.C.1, sole selling agent for Aerex duct axial fans.

DETAILS of the Institute of Metals students' essay prizes are available from the secretary, 4, Grosvenor Gardens, London, S.W.1.

THREE VICKERS VISCOUNT turbo-prop airliners have been ordered by the United States Steel Corporation for use by its executives.

A SUB-COMMITTEE is to be set up by the Industrial Health Advisory Committee to consider major health hazards such as dust, fumes, and dermatitis.

MEADOW FOUNDRY COMPANY, LIMITED, has had plans submitted for the erection of a new workshop and other premises at Littleworth, Mansfield, Notts.

ARGUS FOUNDRY, LIMITED, is planning the erection of a mechanics' shop, garage, water tank and control tower at Boydstone Road, Thornliebank, Glasgow.

AN INVITATION from the Cambridge Instrument Company, Limited, to spend two days visiting its works and research departments was accepted by some 600 members of Cambridge University.

AN AGREEMENT has been concluded by Zirconal, Limited, whereby the special refractories they make will be produced in Germany for the Continental market by Otto Junker of Lammersdorf.

A MARKET REPORT on air compressors in Pakistan (reference ESB 7107/55) has been prepared by the Export Services Branch of the Board of Trade, Lacon House, Theobalds Road, London, W.C.1.

THIS YEAR'S SUMMER VISIT of the Manchester Geological and Mining Society was to the ICI salt mine at Winsford (Ches). About 40 members took advantage of the opportunity to see this example of modern rock-salt mining.

VICKERS-ARMSTRONGS, LIMITED, has received an order from the Chilean Government for the construction at its Barrow shipyard of two destroyers. The propelling machinery and armament will also be supplied by the company.

A ONE-DAY COURSE for foremen is to be held in Glasgow on June 7 by the Industrial Welfare Society, in which delegates will hear lectures, take part in discussions, and watch films with the aim of solving many of the ordinary problems which face first-line management.

AN OFFER has been made by James Burness & Sons, Limited, the London shipping company, for the ship-repairing yard of T. Mitchison, Limited, Gateshead. Last month it was announced that the yard's activities had been extended to building and the London company hopes to build ships there.

SIR CLAUDE GIBB, chairman and managing director of C. A. Parsons & Company, Limited, and chairman of A. Reyrolle & Company, Limited, has been appointed president of the Nuclear Power Plant Company, Limited, which has been registered with £1,000,000 capital in £1 shares. The company's other directors are Mr. H. H. Mullens, managing director of A. Reyrolle & Company, and Mr. A. T. Bowden.

AMONG the donations acknowledged at the meeting of the University Council of the University of Leeds recently, was one of £2,470 from Joseph Booth & Bros., engineers and crane builders, Union Crane Works, Rodley, near Leeds, for the Department of Civil Engineering to purchase equipment.

THE FIRST European conference on statistical quality control will be held in Paris on July 11, 12 and 13. Further details on the conference and the complete programme may be obtained from national productivity centres or direct from the European Productivity Agency (Project 318), 3, rue André Pascal, Paris, 16e.

BRITISH INSULATED CALLENDER'S CONSTRUCTION COMPANY, LIMITED, announce the receipt of an order from the Central Electricity Authority for the erection of a further 92-mile length of the 275,000-volt supergrid between Hams Hall, Birmingham and Melksham in Wiltshire. The work is due for completion by October, 1956.

G. WADDINGTON & SON, LIMITED, Hull, manufacturers of gloves, have opened a subsidiary factory in Cottingham—a short distance from the parent factory at Newland—which has been planned on the most modern and progressive lines. Mr. A. E. Wheldon, who is in charge of the new factory, has 18 years' service with the firm and has "risen from the ranks."

THE Society of Motor Manufacturers and Traders announces that 408,727 cars and commercial vehicles were produced in the first four months of 1955 compared with a total of 324,415 in the same period of last year. During the four months' period car exports averaged three every working minute. Altogether 143,994 cars were exported—21.7 per cent. more than in the same months of last year.

AT YORK, recently, the general council of the Confederation of Shipbuilding and Engineering Unions accepted new proposals for avoiding disputes over alterations in recognized working conditions. They include the introduction of a new standstill period of seven working days in the event of non-agreement in discussions on proposed alterations. The employers' federation will be asked to endorse the proposals.

PLATT BROS. & COMPANY (HOLDINGS), LIMITED, textile engineers, of Oldham—A final dividend of 8½ per cent. to make a total for 1954 equivalent to 12½ per cent. on the present ordinary units as written up from 13s. 4d. to £1 by capitalization of reserves is recommended by the board. For 1953, before the 50 per cent. capitalization, a first and final dividend of 12½ per cent. was paid on £1,373,521. Group profit, before tax, has expanded from £2,197,005 to £2,306,348.

A HEAT-TREATMENT COURSE, held at Oldbury (Staffs) at the end of May by Imperial Chemical Industries, Limited, was attended by many overseas visitors. The company has held three similar courses for foreign visitors, having inaugurated them when it was found that a competing firm in Germany was operating such a scheme. Visitors were conducted on tours of other local works, including those of the Aldridge Tool & Engineering Company, Limited, and Guest, Keen & Nettlefolds, Limited, Smethwick.

FOR 100 YEARS, up to about 50 years ago, Parys Mountain in northern Anglesey was a prosperous centre of copper production. If modern surveying techniques to attempt to rediscover the red metal prove successful, the mountain may again become a thriving centre of production on a commercial basis. The project has the backing of the British Metal Corporation, Limited, and the main landowners concerned have responded favourably to approaches to obtain a licence to prospect.

(Continued on page 608)

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News in Brief

(*Continued from page 606*)

TITANIUM, which developed in about five years from a laboratory curiosity to a very useful metal in aircraft and chemical industries, was among the new elements of growing industrial importance, the production and fabrication of which were studied by an OEEC team, which has just returned from the United States. Other important non-ferrous metals studied were zirconium and beryllium. The mission is to prepare a report on the results of its tour, which will be published later by OEEC.

AN ORDER has been received by Fleming & Ferguson, Limited, Paisley, from the Crown Agents for Overseas Governments and Administrations, for a survey vessel for the Falkland Islands Dependencies. The new vessel will replace the existing survey vessel John Biscoe, which is to be withdrawn from service in the autumn of next year, and the Paisley firm have guaranteed to complete the order within 18 months. The new vessel will be 220 ft. long, 40 ft. broad, and 20 ft. deep, and will be fully strengthened for working in ice. The value of the contract is understood to be about £500,000.

A RESIDENTIAL REFRESHER COURSE for works and plant engineers is to be held at the Clarendon Laboratory, Oxford, from September 26 to 30, under the auspices of the National Industrial Fuel Efficiency Service with the support of the Southern Regional Council for Further Education. There will be 15 sessions given by lecturers eminent in the field of fuel technology. A works visit is also included. The fees for the course will be nine guineas inclusive of meals and accommodation at Brasenose College. Any further information about the course can be obtained from Mr. E. S. Watkin, Ailsa House, 181, King's Road, Reading, Berks.

AMERICAN FUNDS for advisory work on welding have been made available to the British Welding Research Association through the Department of Scientific and Industrial Research. These funds will enable the BWRA to increase its development service to British industry. The service will be based on the Association's considerable experience of research and development and, within the limits of the staff available, assistance will be given on any welding problems which may arise during the next two years. For assistance readers should write to:—Welding Advisory Department, British Welding Research Association, 29, Park Crescent, London, W.1.

MEMBERS of the Whitehead Iron & Steel Company, Limited, met at Newport (Mon) recently for their first annual meeting since the company's return to private ownership. In his address the chairman, Mr. G. H. Latham, referred to the development of the business in the 50 years that had passed since he joined Mr. L. D. Whitehead two years after the formation of the original private company. Net assets in that period had grown from £3,416 to £3,600,000. In 1906, Mr. Whitehead had introduced the new semi-continuous rolling mill from the other side of the Atlantic, and in 1922 the continuous strip mill was brought into operation at Newport.

PLANS HAVE BEEN COMPLETED for a £2,000,000 extension to the Brierley Hill works of Richard Thomas & Baldwins, Limited, it was announced last month. It is stated that extra production capacity is needed at the Cookley works because of increased orders. It is expected that a start on the building will be made as soon as the plans are approved by the Iron and Steel Board, and the Iron and Steel Holding Realization Agency. All the additional capacity will be devoted to the production of cold-reduced low-loss grain-oriented silicon steel, both in sheet and coil form. It is anticipated that the additional supplies will enable electrical plant manufacturers to meet overseas competition. The extensions to the works will mean that a further 300-400 employees will be required. The present force is 1,500.

A CONFERENCE on heat-flow problems, convened by the Institute of Welding, was held at the Selsdon Park Hotel last month and attended by about 20 investigators drawn from industry, the universities and research associations. The discussions, opened by Mr. H. E. Dixon (BWRA) and Mr. J. F. Lancaster (A.P.V. Company, Limited), established the importance, especially in the case of the alloy steels and of the aluminium alloys, of making available acceptably reliable methods of calculating the thermal cycles occurring during welding. On the basis of such data, the welding engineer is able to predict the physical properties of the finished weld and of the heat-affected zone and so to determine, without long and costly experiments, the welding procedures required to produce a satisfactory joint free from cracks and without excessive distortion.

Obituary

Mr. CAROL VAUGHAN MILLER, sales director of Nu-Way Heating Plants, Limited, Droitwich (Worcs), died on May 18 at the age of 57.

Mr. JOSEPH FIELDEN GREENWOOD, a director of the Sandholme Iron Company, Limited, Todmorden (Lancs) died on May 20. He was 62.

The death has occurred of Mr. HARRY BURFORD JUDGE, chairman of Joshua Bigwood & Sons, Limited, engineers and ironfounders, of Wolverhampton, who was associated with other companies.

Mr. JOHN B. WILLIAMS, who has died at the age of 70, was the founder and, until recently, managing director of J. B. Williams & Company (Birmingham), Limited, metal merchants and refiners.

Mr. STANLEY PRIESTLEY BIRD, formerly chief assistant metallurgist in the central research laboratory of Dorman, Long & Company, Limited, Middlesbrough, has died at the age of 67. He retired in 1952.

Mr. JOSEPH MATTHEWS, formerly heat-treatment superintendent of Hadfields, Limited, steelmakers, of Sheffield, has died at the age of 75. In 1946 he was awarded the MBE in recognition of 52 years with the company, for 47 of which he had been superintendent.

Mr. HAROLD GRINSTED, formerly Director of Aircraft Research and Development at the Ministry of Supply, died on May 21 at the age of 66. During the 1939-45 war Mr. Grinsted was Director of Research, Development, and Technical Investigations at the Ministry of Aircraft Production, and when that Ministry closed down in 1946 he took up a similar post with the Ministry of Supply.

Mr. JAMES OAKLEY, M.I.B.E., C.C., chairman and managing director of Stourvale Products, Limited, Cradley, died on May 21, at the age of 63. He was the founder of Oakley Brothers, Limited, Belle Vale Foundry, Cradley, which he founded in 1919 and the interests of which were sold to W. T. Henley's Telegraph Works, Limited, London, in 1945. The firm of Stourvale Products, Limited, was founded as a subsidiary of Oakley Brothers, Limited, in 1934 and was formed into a separate company in 1937.

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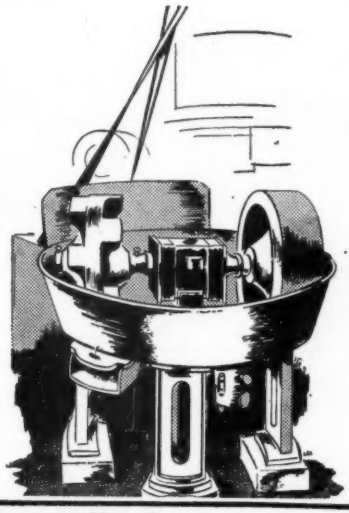

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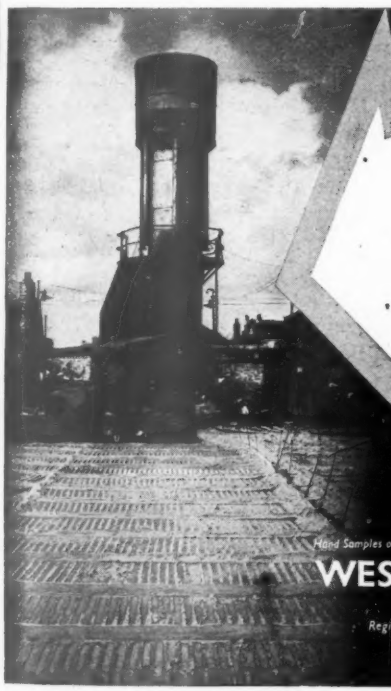

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Personal

LEYLAND MOTORS LIMITED announce the appointment of Mr. H. FLETCHER as employment manager of the company.

Mr. DAVID I. KING, editor of "The British Steelmaker," joined the United Steel Companies, Limited, on June 1 as technical press officer.

Mr. J. C. MENHINICK, of Roxwell, Chelmsford, has been appointed a member of the Domestic Coal Consumers' Council by the Minister of Fuel and Power.

METROPOLITAN-VICKERS has appointed Mr. W. F. CROWTHER as manager, Hull sub-office, and Mr. J. S. HALL as assistant manager, Manchester office. These appointments date from April 1.

Mr. E. BRUCE BALL has resigned his appointment of managing director of Glenfield & Kennedy, and from the boards of Glenfield & Kennedy Holdings and associated and subsidiary companies.

Mr. G. H. THOMAS, of Massey-Harris-Ferguson, becomes vice-president of the parent company and general manager, Canadian Division. Mr. G. W. WELLS becomes assistant general manager.

Mr. D. H. BROWN, of the English Electric Company, Limited, has been appointed, by the Northern Ireland Ministry of Commerce, to the new post of engineer in charge of plans for the use of nuclear energy in the generation of electricity.

Dr. SEAN MACKEY, a lecturer in civil engineering at the University of Leeds, is leaving in July to take charge of post-graduate studies and research work at the new Indian Institute of Technology at Kharagpur, 72 miles from Calcutta.

Mr. D. R. S. TURNER has been appointed manager, Larne Works (N. Ireland) of the British Thomson-Houston Company, which when completed will be devoted to the manufacture of the largest steam turbines and turbo-generators of 30 mw. upwards.

Mr. EDWARD PARKINSON, of J. Parkinson & Son (Shipley), Limited, machine-tool makers, Canal Ironworks, Shipley, was elected president of the Bradford Rotary Club at the annual meeting on May 20 He has been a member of the Bradford club for 24 years.

MR. J. E. BELLISS, managing director of Belliss & Morcom, Limited, has been elected senior vice-president of the Birmingham Chamber of Commerce, and MR. R. P. S. BACHE, managing director of George Salter & Company, Limited, junior vice-president.

BIRLEC, LIMITED, which has recently joined A.E.I., Limited, announce the appointment of MR. K. L. MOON as sales manager of their induction heating division. MR. A. E. PICKLES continues as manager of the division, with overall responsibility, and MR. R. ABBOT as technical manager.

THE GOLD MEDAL of the Institution of Mining and Metallurgy has been awarded to Emeritus Professor WILLIAM RICHARD JONES, a past-president of the Institution, in recognition of his services to the science of economic geology and to the Institution. The Gold Medal is the highest honour that the Institution can confer.

NORTH BRITISH STEEL FOUNDRY LIMITED, Bathgate, announce the election of MR. JAMES DAVIDSON PAUL to the board. Mr. Paul, a well-known local man, started with the company as an apprentice chemist 25 years ago, since when he has held various posts within it, including chief metallurgist, foundry manager and works manager, which latter appointment he still holds.

THE BRITISH TRANSPORT COMMISSION announces the appointment, as supplies and production adviser to the Commission, of Mr. E. L. GETHIN, at present deputy chief contracts officer at the London headquarters of the Central Electricity Authority. Mr. Gethin, who will take up his new appointment on June 13, will be responsible for the proper utilization of the Commission's industrial facilities, and for the co-ordination of its purchasing programmes.

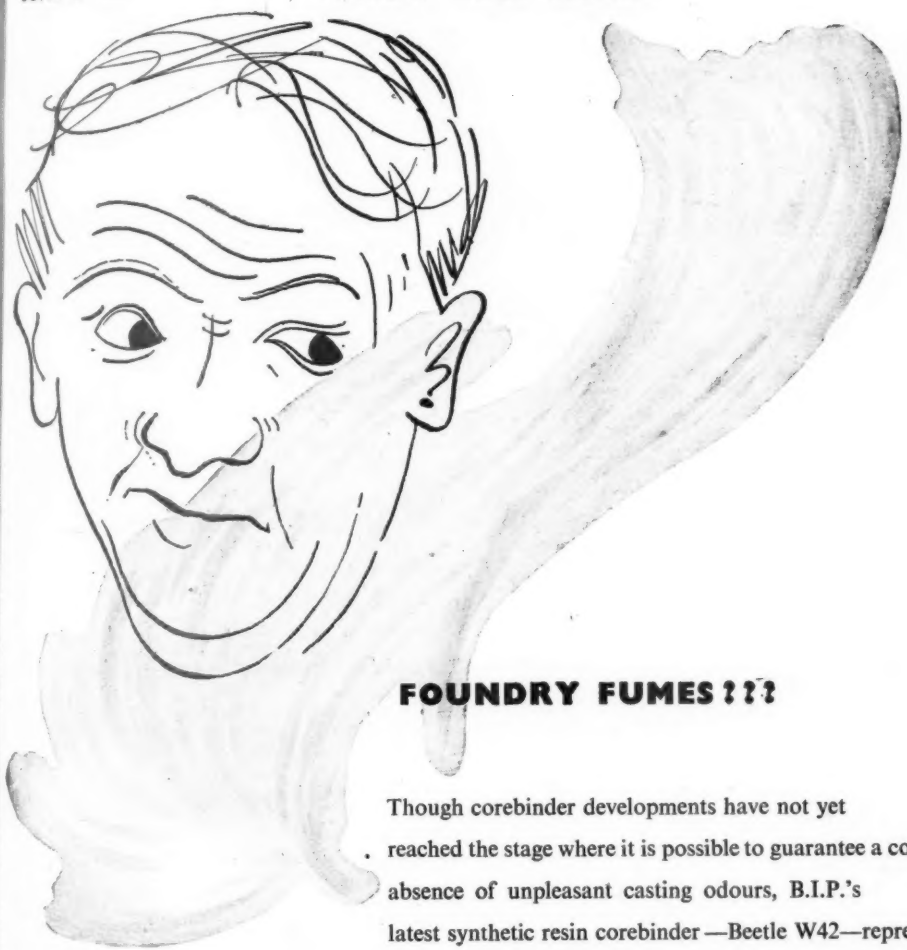
Mr. WALTER CRAFTS and Mr. RUSSELL FRANKS, of the research department of the Union Carbide Company, a United States firm with a British subsidiary, have been touring a number of Sheffield steel firms and conferring with Sheffield technologists on recent developments in metallurgy. They came over at the invitation of Mr. THOMAS POWELL, managing director of British Electro Metallurgical Company, Limited, Grange Mill, Wincobank, Sheffield, which is part of the British subsidiary.

Mr. S. J. CLARKE is to be manager of the Manchester district office of the British Thomson-Houston Company, Limited, as from the end of last month. Until recently he was manager of the company's Newcastle-upon-Tyne district office. As previously announced, Mr. Clarke is succeeded at Newcastle by Mr. H. G. HARLOW. Mr. F. C. BARFORD, who has been manager of the BTH Manchester district office since November, 1952, is to succeed Mr. J. CLEMENT as manager of the company's Birmingham district office on June 15. Mr. Clement will be taking up another position within the BTH organization.

Capt. H. LEIGHTON DAVIES, assistant managing director of the Steel Company of Wales, Limited, and general manager of the tinplate division of the company, left recently for New York *en route* for Trinidad. He has been appointed a member of a board of inquiry set up by the Government to inquire into the cause and circumstances of a dispute between the Oilfield Employers' Association, Trinidad, and the Oilworkers' Trade Union. The inquiry covers all relevant circumstances leading to the dispute, the future of the Trinidad oil industry, and the economy of the colony as a whole.

Mr. WILLIAM JAMES is to become president of the Willenhall Rotary Club for the year beginning in July. He was the club's founder president in 1934 and will therefore hold the chief office during the coming-of-age celebrations. Mr. James is a member of the executive committee of the Midland Ironfounders' Association and of the National Ironfounders' Employers' Federation as well as of the executive of the council of the Ironfoundry Association for Education and Training. He is also chairman of the governors of Wednesbury County Commercial and Technical Colleges.

AFTER 33 YEARS as managing director and latterly chairman of Metal Industries, Limited, Mr. R. W. MCCRONE is retiring from the board of the company in order to devote himself more freely to other interests. The directors are recommending his appointment as one of the honorary presidents of the company. Mr. McCrone, who is 62, was one of the founders of Metal Industries, and became chairman in 1951. He has been associated with many other companies both inside and outside the MI group, including Sentinel (Shrewsbury), Limited, locomotive manufacturers, etc., and Shipbreaking Industries, Limited, of which he has held the chairmanships, while he has served on the boards of the British Oxygen Company, Limited, Alley & McLellan, Limited, and Electrical Switchgear & Associated Manufacturers, Limited.



FOUNDRY FUMES???

Though corebinder developments have not yet reached the stage where it is possible to guarantee a complete absence of unpleasant casting odours, B.I.P.'s latest synthetic resin corebinder—Beetle W42—represents a very considerable advance in this direction. Developed with the Garrett Report in mind, it combines all the advantages of Beetle W20 with a reduction in casting odour that will be appreciated by foundrymen.

use* BEETLE RESIN W42* *for reduced casting odour

B·I·P

Write for technical information to B.I.P. Chemicals Limited, Tat Bank House, Oldbury, Nr. Birmingham. London Office : 1 Argyll Street, W.1.

'Beetle' is a trade mark registered in Great Britain and in most countries of the World.

**Patent Application 32896/58*

Raw Material Markets

Iron and Steel

There are still only 100 British blast furnaces at work, compared with 105 a year ago. Therein lies the explanation of the slow expansion of pig-iron production. But explanations are a poor substitute for supplies, which are now urgently needed both in the melting shops and the foundries. Approximately 200,000 tons of iron have been taken from stock in the last six months, and the probability is that these erosions will continue until more furnaces are brought into operation. The volume of imports has fallen short of expectations and most of the foreign iron coming to hand is going into direct consumption in the steelworks. Thus, the increased requirements of the foundry trade cannot be fully satisfied and some establishments have for weeks been working on a hand-to-mouth basis.

The absence of stocks at foundries and furnaces makes the ironfoundry industry all the more vulnerable to shock tactics on the labour front. At the time of writing the strike of railway footplate men is only a few days old, but the effects are already being felt and if the strike continues the situation will quickly become serious. With capacity fully engaged and raw material supplies in the form of pig-iron and coke barely adequate to requirements the industry is not equipped to sustain a prolonged break in supplies.

Without booking any more orders the re-rolling mills have plenty of work in hand to keep them busy for several months ahead—providing they are allowed to work. Their chief difficulty is to procure the material to keep to capacity working and re-rollers will be the first to feel the effects of delivery delays caused by the rail strike. Billet imports have been stepped up considerably, but further expansion is called for.

By far the biggest increase in the demand for finished steel products has been encountered by the rollers of flat products. The phenomenal activity of the motor trade and its plans for further expansion call for tonnages of sheets far in excess of anticipations, and further increases in productive capacity are now planned. Rollers of joists and sections are generally booked up to the end of August; and it is expected that pressure will increase as the capital investment programme matures.

Non-ferrous Metals

The British Bureau of Non-Ferrous Metal Statistics for March, at 67,566 tons, showed a reduction of about 2,600 tons, while consumption was 41,083 tons of refined and 16,712 tons of scrap, a total of 57,795 tons, which compared with 50,705 tons in February. Stocks of zinc at the end of March were 49,301 tons, compared with 45,679 tons a month earlier, while consumption, all grades, at 33,451 tons, showed a useful increase over the February figure of 28,814 tons. In lead, a similar trend was in evidence, for usage, all grades, in March was 33,225 tons, against 28,926 tons in February. Stocks of virgin and refined lead, on the other hand, moved down by nearly 2,000 tons to 37,587 tons. Stocks of tin increased from 4,353 tons to 4,821 tons and consumption also improved—from 1,843 tons to 2,057 tons. April world statistics (in short tons) gave production of crude copper at 103,900 tons, a drop of 4,500 tons in the USA, with output of refined at 122,100 tons, a reduction of 13,600 tons. Deliveries of refined copper were 11,500 tons down at 119,900 tons. Outside the USA production of crude copper was 4,600 tons up, at 138,400 tons, while output of refined copper gained 600 tons to 102,400 tons. Deliveries of refined copper, however, were up by 2,200 tons to 101,500 tons.

Last week the copper situation was enlivened by the adjudication of the Government tender for electrolytic copper, quotation for which had been submitted a few days earlier. It would appear that a considerable number of firms, both merchants and consumers, were successful and the 15,000 tons was well spread round. No details of terms of purchase have been published, but it is known that the basis is the average LME settlement price for the month of delivery plus, in most cases, some sort of a premium. Delivery is spread over the next few months. Somewhat contrary to expectations, copper gained ground last week, closing £7 up for cash and £13 10s. better for three months. The backwardation narrowed to £13. Cash tin rose £1, but three months lost 10s. Zinc gained 25s. prompt and forward 15s., while lead dropped 10s. and 5s. for the respective positions.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* May 26, £330 to £331; May 27, £332 to £334; May 31, £332 to £334; June 1, £333 to £334.

Three Months: May 26, £317 to £317 10s.; May 27, £320 to £321; May 31, £321 to £322; June 1, £319 to £320.

TIN, Standard—*Cash:* May 26, £715 10s. to £716; May 27, £716 10s. to £717; May 31, £719 to £720; June 1, £718 to £718 10s.

Three Months: May 26, £717 10s. to £718; May 27, £717 10s. to £718; May 31, £719 10s. to £720; June 1, £718 to £718 10s.

LEAD—*Second half May:* May 26, £103 5s. to £103 10s.; May 27, £102 17s. 6d. to £103; May 31, £103 5s. to £103 15s. *First half June:* June 1, £103 to £103 5s.

Second half August: May 26, £102 15s. to £103; May 27, £102 12s. 6d. to £102 15s.; May 31, £102 12s. 6d. to £102 15s. *First half September:* June 1, £102 15s. to £103.

ZINC—*Second half May:* May 26, £90 10s. to £91; May 27, £91 to £91 5s.; May 31, £91 10s. to £91 15s. *First half June:* June 1, £91 5s. to £91 10s.

Second half August: May 26, £88 15s. to £89 5s.; May 27, £89 to £89 5s.; May 31, £89 5s. to £89 10s. *First half September:* June 1, £89 10s. to £89 15s.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade, Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone CHAncery 4411, ext. 738 or 771), unless otherwise stated.

NEW ZEALAND, June 21—Phosphor-bronze rods, for the New Zealand Post Office. (ESB/10578/55.)

FORMOSA, June 11—Engine and machinery spare parts for the Central Trust of China, US Aid Division. (ESB/9604/55.)

KENYA, June 6—1,210 water meters, for the City Council of Nairobi. (ESB/10541/55.)

SOUTH AFRICA, June 3—Stainless steel ware, for the Transvaal Provincial Administration. (ESB/10943/55.)

EXAMPLES of shell moulds and castings made by the shell-moulding process are featured in the display on the three-in-one stand (No. 65) of the Distillers plastics companies—British Geon Limited, British Resin Products Limited, and Distrene Limited—at the British Plastics Exhibition (Olympia, June 1 to 11).

HOOKERLITE CORE TRAYS

are

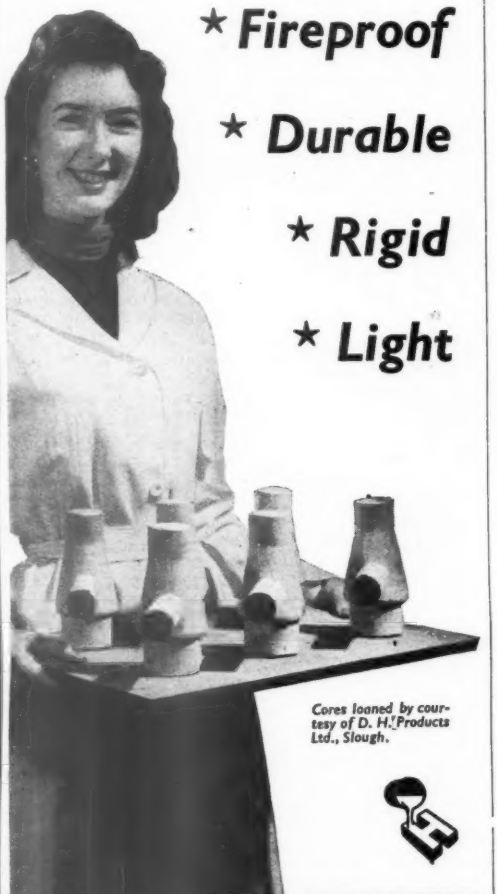
★ *Economical*

★ *Fireproof*

★ *Durable*

★ *Rigid*

★ *Light*



Cores loaned by courtesy of D. H. Products Ltd., Slough.

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The Barber of Seville

HE IS AN ARTIST; and, as artists should, he chooses his instruments most carefully. He chooses British-made razors.

So do millions of self-shavers all over the world. Nearly six million British safety razors went overseas last year and close on seven million *gross* of blades went with them.

Razors and rolling stock, paper clips and cars—an infinite variety of British steel goods is helping to raise Britain's exports to record levels.

Wherever there is steel there is British steel.

British steel leads the world

THE BRITISH IRON AND STEEL FEDERATION
5.94

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

June 1, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £15 12s. 0d.; Birmingham, £15 5s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 13s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £18 9s. 3d.

Scotch Iron.—No. 3 foundry, £18 2s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £20 4s. 0d.; South Zone, £20 6s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £21 1s. 6d.; South Zone, £21 4s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £18 2s. 6d.; Scotland (Scotch iron), £18 9s. 0d.; Sheffield, £19 7s. 6d.; Birmingham, £19 14s. 6d.; Wales (Welsh iron), £18 9s. 0d.

Basic Pig-iron.—£15 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots).—40/55 per cent., £40 15s. 0d., basis 45 per cent. Si, scale 15s. per unit; 70/84 per cent., £63 0s. 0d., basis 75 per cent. Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £161 0s. 0d. to £165 0s. 0d. per ton; 38/40 per cent., £258 0s. 0d. to £262 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 17s. 0d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 0d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £83 0s. 0d. to £86 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £81 0s. 0d. to £84 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 10½d. per lb. Cr; 1 per cent. C,* 1s. 11d. per lb. Cr; 0.15 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 10d. to 7s. 4d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £53 17s. 6d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 5s. 0d.; tested, 0.08 to 0.25 per cent. C, £26 5s. 0d.; hard (0.41 to 0.60 per cent. C), £27 10s. 0d.; silico-manganese, £34 10s. 0d.; free-cutting, £29 6s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 17s. 0d.; silico-manganese, £34 10s. 0d.

* Average 68-70 per cent.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 15s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £33 11s. 6d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 19s. 6d.; flats, 5 in. wide and under, £31 19s. 6d.; hoop and strip, £33 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £34 5s. 0d.; black sheets (hand mill), 17/20 g., £43 13s. 6d.; galvanized corrugated sheets, 24 g., £55 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £54 7s. 9d.; nickel-chrome, £76 7s. 9d.; nickel-chrome-molybdenum, £86 8s. 6d.

NON-FERROUS METALS

Copper.—Cash, £333 0s. 0d. to £334 0s. 0d.; three months, £319 0s. 0d. to £320 10s. 0d.; settlement, £334 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 1½d. per lb.; rods, 367s. 9d. per cwt. basis; 20 s.w.g., 401s. 0d. per cwt.

Tin.—Cash, £718 0s. 0d. to £718 10s. 0d.; three months, £718 0s. 0d. to £718 10s. 0d.; settlement, £718 10s. 0d.

Lead (Refined Pig).—First half June, £103 0s. 0d. to £103 5s. 0d.; first half September, £102 15s. 0d. to £103 0s. 0d.

Zinc.—First half June, £91 5s. 0d. to £91 10s. 0d.; first half September, £89 10s. 0d. to £89 15s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £122 10s. 0d.; rolled zinc (boiler plates), all English destinations, £120 5s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 7½d. per lb.; rods, drawn, 3s. 4d.; sheets to 10 w.g., 328s. 0d. per cwt.; wire, 3s. 1½d.; rolled metal, 313s. 9d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £207; B6 (85/15), —; BS249, £218.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £269; HTB2 (38 tons), £272; HTB3 (48 tons), £281.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £287; LG3 (86/7/5/2), £296; G1 (88/10/2/1), £364; (88/10/2/1), £354.

Phosphor Bronze.—BS1400, PB1 (AID released), £379 per ton.

Phosphor Bronze Strip, etc.—Strip, 456s. 0d. per cwt.; sheets to 10 w.g., 479s. 6d. per cwt.; wire, 4s. 8½d. per lb.; rods, 4s. 0¾d.; tubes, 3s. 11d.; chill cast bars: solids 4s. 1¾d., cored 4s. 2½d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide x 0.056, 3s. 10¾d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4¼d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3¼d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £108 0s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £163 0s. 0d.; aluminium bronze (BS1400), AB1, £339; AB2, £345. Solder, brazing, BS1845, 2s. 10d. lb.; granulated, 3s. 2d. lb.